THE RAILROAD AND
ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT No. 145 BROADWAY, NEW YORK.

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Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid.....$3 00
Subscription, per annum, Foreign Countries..... 3 50
Single copies..... 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

NEW YORK, FEBRUARY, 1891.

THERE is to be held at Prague, in Bohemia, beginning in May next, an exhibition which will mark the centennial of what, it is claimed, was the first trades exhibition ever held in Europe, which took place at Prague in 1791. It will last from May to October 15, and American inventors are especially requested to contribute devices for the prevention of accidents in industrial works, and inventions of a similar class.

THE engineer who has run a line through the mountains of Colorado or the forests of Maine or Michigan has doubtless had his trials and hard experiences, but it may be a question whether his work was really harder than that of a party of surveyors who were recently observed taking levels and measurements along lower Broadway in New York during the busiest hours of the day. Natural obstructions presented by mountain and forest can be overcome by perseverance, but to sight a transit or use a tape-line in the throng of vehicles and foot passengers which filled the street required a degree of patience and care which certainly deserve mention at least, if not reward.

IT is announced that a contract has been concluded under which the Baltimore & Ohio Railroad is to send freight to New England by way of the Poughkeepsie Bridge. The connection with the bridge is to be made over the Philadelphia & Reading tracks from Philadelphia to Slatington, Pa., and thence over the Pennsylvania, Poughkeepsie & Boston Railroad.

The Baltimore & Ohio has never had a very large share of New England traffic, which has gone mainly by the more northern trunk lines. Such freight business as it has had to and from that section has heretofore gone by way of New York. With the new connection its share may increase, and, at any rate, it will probably be large enough to make a welcome addition to the business and revenues of the bridge and the railroads which cross it.

THE season of navigation on the Erie Canal closed early in December, and on the lakes about the middle of the month. A repetition of the very mild and open winter of 1889-90 was hardly to be expected, and there is every indication of a more severe season than has been seen for several years past.

During the season of navigation now closed the freight business done on the lakes and canals has been very large, but vessel and boat owners claim that it has not been profitable for them, chiefly on account of the competition caused by the great increase in the number and tonnage of vessels. There is considerable truth in this, without doubt; but the business is still profitable enough to cause the building of a number of new vessels, though there is some falling off from the construction of recent years.

THE probabilities seem to be that there will be no National legislation on irrigation by the present Congress. In the long session so much time was taken up by political legislation and party struggles that the subject was passed by almost entirely, and the present session will be too short to give any opportunity for action. Some legislation is needed, and too long a postponement may cause trouble in the future. The new Congress will be so different a body from the present one, and will contain so many new members, that it is not easy to predict what sort of action it may take on the Irrigation question, or whether that subject will be neglected entirely.

THE permanence of the supply of natural gas is an important question in some parts of the country. Scientists differ very much in their opinions, and only experience can decide. In Pittsburgh recently there has been a deficiency in the supply, and many factories have been obliged to go back to coal, at considerable trouble and expense to themselves. In Ohio and Indiana also it is reported that a decrease in pressure has been observed at some of the gas-wells, and the supply is diminishing. This will cause some local disturbance, but the coal operators will be inclined to accept the situation philosophically.

THE reports from the Nicaragua Canal are favorable. Much progress has been made in the preliminary work of clearing and preparing to begin the work of excavating the canal. The railroad which is to run alongside of the canal line to facilitate the work is well advanced toward completion, and the improvement of the harbor at the Atlantic end of the canal is in progress. Several of the large dredges which were in use on the Panama Canal have been secured and brought up to Greytown, where they will soon be at work excavating. Everything will soon be in readiness for the actual work of excavating the canal itself.

The preliminary works are considerable in extent and importance, so that a substantial advance has been made already, while the prospects for the future are encouraging.

IN a recent article in the *Revue Scientifique* Mr. Daniel Bellet calls attention to the number of projects for ship canals which are now attracting attention in Europe. Those actually under construction include the Corinth Canal, the Manchester Canal, the Baltic-North Sea Canal and the improvement and canalization of the Loire, which will enable sea-going vessels to ascend that river to Nantes.

Among projects which have not yet reached the stage of actual work are the canals to Paris and to Berlin, both of

which have been referred to in our columns; the Forth & Clyde Canal in Scotland and the Escaut Canal in Belgium, which is to make Brussels accessible to large vessels. Other plans, which must be considered as entirely on paper as yet, not having reached even the stage of survey and location, are for a canal across Southern France from Bordeaux to Narbonne, to connect the Atlantic and the Mediterranean; a connection between the Black Sea and the Caspian; the White Sea Canal in Russia and the canalization of the Tiber up to Rome. All of these have their earnest advocates among the engineers of the countries in which they are planned.

It may be noted here, as a curious illustration of French feeling in the matter, that a writer so well known as M. Bellet refers to the Panama Canal as the next great interoceanic connection which will follow the Suez Canal, and adds: "We do not know that it is necessary to consider as serious the project of an interoceanic canal by way of Lake Nicaragua."

To us on this side of the water this looks like a deliberate reversal of the actual state of facts, but in France it seems that there is a large majority which still looks upon the Panama Canal as certain of completion, and refuses to recognize that substantial progress has been made on the Nicaragua Canal.

THE new railroad mileage built in the United States in 1890, according to the figures collected by the *Railway Age*, amounted to 6,080 miles, which is 850 miles more than was reported in 1889. While the year was not an unusual one in point of railroad construction, it was fully up to, and in fact rather over the average, which for the past 20 years has been 5,700 miles yearly. Indeed, it has never been exceeded largely except in the three years 1880, 1883 and 1888.

About one-third of the new mileage reported was in the South Atlantic and Gulf States, where 2,006 miles are reported; one-sixth was in the Southwestern States, including New Mexico and Arizona, and another sixth, 1,047 miles, in the Northwestern States beyond the Mississippi, the latter being chiefly accounted for by the large additions made to the mileage of the Northern Pacific and the Great Northern Roads. The Pacific Coast States make a fair showing with 624 miles, more than half of which was in Washington, while the building in the Central States, from Ohio to Wisconsin, furnished 802 miles. The large increase made in the South is in continuation of the work of the preceding two years, in both of which that section showed a greater increase than in any other part of the country.

The 6,080 miles reported were on 337 different lines, giving an average for each one of only 18 miles, and showing that a very large proportion of the railroad building done in 1890 was on short lines and branches of existing roads. To only three lines, in fact, was the addition more than 100 miles, and only a few others report over 50.

The leading State in new mileage was Montana, in which there is plenty of room for railroads, and in which 421 miles were built, the State profiting largely by the rivalry between the Great Northern and the Northern Pacific. The other States reporting large increase are Georgia, 375 miles; Washington, 341 miles; North Carolina, 309; Texas, 253; Alabama, 253; Pennsylvania, 252; Virginia, 228; Ohio, 223; Kentucky, 22; Nebraska, 218; Colorado, 211 miles. The States showing the least mileage are Iowa and Nevada, each reporting a single mile.

THE New York Aqueduct Commission has approved the report of its Construction Committee, recommending that steps be taken at once to build the new Croton Dam on the site recommended by the Chief Engineer Fteley. Mr. Fteley's plan, as we have heretofore noted, provided for the abandonment of the proposed great masonry dam at Quaker Bridge and the erection of a smaller dam at a point a short distance below the old Croton Dam, which would furnish storage capacity enough for a number of years to come, and could be built at a very much less cost than the Quaker Bridge Dam.

THE latest rapid transit plan for New York City has been presented by Mr. Austin Corbin, who proposes to build a tunnel from 50 to 60 ft. below the surface, starting from the Battery, running under Broadway and the Boulevard, under the Harlem and as far north as Van Cortlandt Park, near the northern limit of the city. It will then turn eastward to Fordham and south along Third Avenue to Union Square, where it will rejoin the line from the Battery. Two loops or branches are also proposed, one from the Battery up the west side of the city, near the Hudson River, to the main line near Forty-second Street; the other from the Battery up the east side to the Third Avenue line at a convenient point. In connection with this line it is proposed also to build a tunnel under the East River to Brooklyn and one under the Hudson to Jersey City, connecting with the railroad stations there.

A deep tunnel will cost more to build than a viaduct or elevated railroad, but, on the other hand, it will not require the enormous expenditures for right-of-way and damages to adjoining property which are inevitable with a line on the surface. As an engineering work the tunnel is entirely practicable.

IT is proposed to hold a celebration in Washington in April next to commemorate the end of the first and the beginning of the second century of the American Patent System, the first patent having been issued in April, 1791. There has been formed a Central Executive Committee with an Advisory Committee, including a number of distinguished names, and it is hoped that the movement will be seconded by the inventors of the country and others interested in such a way that the event will be celebrated in a fitting manner. All who desire to take part or assist can secure information by writing to the Secretary of the Executive Committee, Mr. J. Elfreth Watkins, whose address is at the United States National Museum, Washington.

In this connection it is proposed to organize a national association of inventors, the Centennial Anniversary being considered an excellent time for such a purpose.

THE Navy Appropriation Bill, as reported by the House Committee in Washington, makes provision for only one new vessel, and that is a triple-screw protected cruiser of 7,350 tons displacement, to cost $2,750,000 without armament. This vessel presumably is to be a companion to Cruiser No. 12. The bill provides for an appropriation of $960,000 for the equipment of new ships and $4,000,000 for their armament. The amount provided for the con-

struction of ships and machinery already authorized is $11,607,000.

A provision in the bill, as reported, allows the Secretary to use $100,000 of the amount appropriated at the last session for nickel ore to make tests in the development of American made armor-plates. An interesting item in the bill provides $25,000 for equipment and arms for naval militia in the various States, this allowing the Secretary to provide for the naval reserve.

THE last Board of Experts which has been considering the question of the Brooklyn Bridge traffic has made a report recommending a plan for the arrangement of the terminals, so as to increase the capacity of the bridge railroad. The experts consider that the use of the loop or continuous track system for the New York terminal is rendered impossible on account of the enormous cost of obtaining sufficient real estate, and their plan is substantially for the enlargement of the present system, providing additional platforms and additional switching tracks, so that the number of trains may be increased. The experts believe that with these arrangements the headway between these trains can be reduced to 45 seconds, increasing the capacity of the railroad, with four-car trains, from 16,000 to 32,000 passengers per hour. This, they think, will be sufficient to provide for the traffic for some years to come. It is not understood that they recommend this as the best possible arrangement, but only as the best attainable under existing circumstances.

THE DISCOMFORTS OF RAILROAD TRAVEL.

IN an admirable essay on Organization in Daily Life, the Author, Sir Arthur Helps, said:

> If you want to improve the administration of railways, I will tell you how to do it. Look out for a very ingenious, sickly man, with a large family, and give him £4,000 a year as an inspector of railways. Let him make short reports, in good English, of his sufferings on the different railways, specifying names, dates and every particular. He must be bound to travel occasionally with his whole family, in the depth of winter. We do not know of their sufferings sufficiently in detail. An ordinary person would be ashamed to describe these minutiæ; but it must be this man's business. Besides, seriously speaking, he would meet with great differences of treatment. One thing is well managed on this railway, another on that. He would be able to praise as well as to blame. There is one railway I know of on which, to my judgment, the coupling of the carriages is not sufficiently attended to. There is another railway on which I have never found the same fault. My inspector would tell the world these things, and an effect would be produced upon the traffic of these lines.

Probably few of the subscribers of this JOURNAL will read the above suggestion without feeling a desire to be appointed such an inspector, not alone for the salary of £4,000, but from a sort of instinct of reform which most active-minded people feel, and which manifests itself in a longing to set those things right which, in their judgments, are going wrong. While such an appointment and salary would not be easy to get, any of us may indulge in the hypothetical exercise of the duties and privileges of the office—without the salary. The writer has a sufficient amount of overweening vanity to imagine that he has some of the qualifications required of such an inspector. He is sufficiently ingenious to be called a "crank," and though not exactly sickly, he has a digestive apparatus which does not consume its fuel as successfully as a locomotive with a brick-arch does. He has not a large family, but he nurtures a brood of cares, anxieties, duties and responsibilities which he takes with him in his travels and which are perhaps as troublesome as a family would be. He can make a report in English which competent critics would reject as a model of style, but it has the merit of being comprehensible. He therefore assumes the office of a self-appointed inspector of railroads, and submits this his

FIRST REPORT.

Those of us who have passed the semi-centennial divide, which separates the ascent from the descent of life, can remember when few other luxuries were provided for railroad travelers excepting peanuts and ham sandwiches. At that time any distinction of classes or persons when traveling, or in the accommodations afforded them, was regarded with disfavor. Foreign immigration and other causes has since then made such a distinction desirable to those whose person, clothes, and language are clean; and prosperity has enabled many of our countrymen, and not a few of the immigrants, to pay for exclusiveness, comfort, and luxury. These causes have created the demand which enterprising companies have supplied, and now on nearly all first-class railroads some kinds of cars are run on both day and night express trains which are intended to give some degree of exclusiveness and more comfort and luxury than is afforded by ordinary cars to those who want it, and are willing and able to pay for it. As remarked, such cars are intended to be more comfortable, more luxurious, and to give more protection from the aggressiveness of disagreeable people than the other cars are or do, and for such accommodations many travelers are ready and willing to pay an extra charge. The traveler pays so much money for an expected amount of gratification. The bargain is therefore a fit subject for criticism, if he does not get full value for the charge imposed, or if the accommodations furnished him are attended with annoyances which disturb his serenity or defeat the object for which he has expended his money. To show that there are some such disturbances is the object of this report, in which day travel will be considered first.

It may be said of this, with little risk of contradiction, that one of the chief reasons which leads many persons to travel is the pleasure of looking on new scenes or of "seeing the country." This is especially the case in those sections where the scenery is attractive, but even in other regions the constant variety and succession of scene is diverting and supplies a quiet sort of entertainment, which requires no active mental effort to enjoy, and is consequently very restful and recuperates the tired mind and body to a wonderful degree.

If, then, seeing the country is one of the chief objects for which many persons travel, and is a great pleasure to all, it would seem that to lose sight of that object in designing cars, and to arrange them so that it is difficult and uncomfortable to see the passing landscape from them, is almost as senseless as any act of human unwisdom could be. Nevertheless in arranging the windows and seats of many drawing-room cars apparently no thought has been given to the convenience or comfort of the passengers in seeing out of them. Such cars are often so constructed that passengers are unable to see out of the windows without either riding backward, or craning their necks, or doing both in a most uncomfortable and annoying way. Apparently the cars have been constructed and the windows arranged without any reference whatever to the seats, or, in other words, the cars are built first and

the seats are arranged afterward in the best way that is then possible. When the windows are very wide, as they are in some such cars, not only must every alternate passenger ride backward, but in some of them every third passenger has a panel alongside of his or her chair, so that it is difficult to see out of the car in riding either backward or forward. The arrangement seems to be especially designed for shutting out the view of the country through which the passenger is traveling. The persons responsible for such plans should be obliged to travel blindfold, and not be permitted to design or sanction the design of any new cars until they had learned enough mechanical drawing to be able to lay out a plan of a car showing the seats arranged in some sort of reasonable relation to the windows.

The reason for using the large windows in drawing-room cars is inscrutable, and eludes the most thorough investigation of common sense. They are inconvenient to raise and lower, are more expensive, and do not serve the purpose of seeing out of—which is the main purpose of windows—as well as those of ordinary size do. The sole object in using them seems to be that which induces so many architects to make the interiors of houses inconvenient and uncomfortable—that is, to make them look well from the outside. Windows in cars are like wives and tooth-brushes, each man should have exclusively his own.

The most distinctly luxurious appliances which have been adopted recently on cars are vestibules. For these it is claimed that they give a clear passage-way from one end of the train to the other, and that persons passing from one car to another are not in danger of falling off the platforms nor exposed to the weather, and that in addition thereto the vestibules increase the strength of cars very materially to resist collisions.

The complaint has however been made that they conduct the impure air from the front cars to those behind them, and prevent the admission of fresh air between them. The complaint is therefore very common that vestibule trains are badly ventilated. A little of the writer's experience some months ago will illustrate this. In a journey from Baltimore to New York he happened to take a train "bearing this strange device" *F. F. V. Limited*, the cars of which were all vestibuled. The train seemed to be supplied with every luxury excepting fresh air. The atmosphere inside the cars at Baltimore was vile. After leaving there it continued to grow viler and more villainous, and odors rank of boiled chicken, ham sandwiches, sulphuretted hydrogen, personal exhalations and atmospheric sewage were commingled in a nauseating mixture. At Philadelphia it seemed as though the atmosphere would no longer support combustion or life, and some of the passengers were compelled to go out into the fresh air or incur the danger of fainting away. The meaning of the "strange device" referred to has been deciphered in different ways, but the writer is convinced that F. F. V. means *Fright-fully Ventilated*. For this ventilation, or rather the want of it, the vestibules were in great measure responsible. When these are not used a little fresh air must come in when the doors are opened, or it can be admitted to better advantage by suitable ventilators at the ends of the cars than anywhere else. With the vestibules this supply is excluded, and instead the first car furnishes air to the second which has undergone one degree of vitiation; from the second it passes to the third with two degrees of contamination, and from the third it escapes to the fourth with three degrees of pollution, until in the last car it is only fit for railroad directors and superintendents to breathe. If we must have vestibules, give us decent ventilation. To have that there must be some adequate provision for the admission of a constant supply of fresh air. This provision has not been made in vestibuled trains, and the ventilation in many of them is execrably bad.

Considering the importance of ventilation in cars and how much has been said and written about it, it seems remarkable that so little has been accomplished to improve it. When mankind fall into error it is because they either believe something which is not true or do not believe something which is true. Now in car ventilation the true thing that is not believed is *the absolute need of furnishing an adequate supply of fresh air to keep the atmosphere in a car pure.*

The average car-builder and architect will always assume that by simply making a number of holes in the top of a car or apartment that the bad air will escape, but he never seems to inquire how the fresh air, which must take its place, will get in. We remember once seeing the principle of ventilation illustrated very forcibly in a car-shop. It was found that newly varnished blinds for car windows would not dry unless a certain amount of warmth was supplied. A close apartment or drying chamber was then constructed, which was warmed with steam-pipes. In it the drying proceeded to a certain extent and then stopped. Investigation showed that the air in the chamber absorbed a certain quantity of the volatile constituents of the varnish, but would take up no more than a given amount. If the air which was thus charged was removed and a fresh supply was furnished the drying continued, which led to a system of ventilation by a fan, which forced air into the chamber, and that which had absorbed some of the component parts of the varnish escaped through suitable openings. Simply adding ventilators for the escape of vitiated air was not sufficient. A constant and certain quantity of that which was fresh had to be admitted to the drying chamber. The same principle applies to car ventilation. *There must be an adequate supply of fresh air to keep the atmosphere in a car pure.* Such a supply is not ordinarily furnished on the vestibule trains.

Another very common evil in drawing-room and sleeping cars is the location and arrangement of the smoking-rooms. It is rare when one of these is at the front end of a car that the latter is not pervaded with the disagreeable odor of stale tobacco smoke. Either the smoking-room should be entirely excluded from such cars or some better arrangement should be devised for keeping the smoke out of the rest of the car.

Further criticism must be reserved for a future report.

THE RULO BRIDGE.

THE RULO BRIDGE: *A Report to Charles E. Perkins, President of the Chicago, Burlington & Quincy Railroad;* by George S. Morison, Chief Engineer of the Rulo Bridge.

The title of this book indicates its purpose without further explanation. It is a volume of 70 pages which measure 21¼ × 13¾ inches. The bridge described carries part of the Chicago, Burlington & Quincy system across the Missouri River at Rulo, which is located in the southeastern corner of

Nebraska, near the point where that State, Kansas and Missouri unite.

The Report of Mr. Morison gives first a history of the bridge, which is followed by a general description, from which the following extract is taken:

The Rulo Bridge is a single-track railroad bridge. It consists of three channel spans each 375 ft. long between centers of end pins, resting on four piers of granite masonry, at each end of which are three 125-ft. deck spans, being separated by iron towers 25 ft. long, making the length of the iron structure at each end of the channel spans 425 ft. . . . . The entire length of the whole structure from end to end of iron or steel work is 1,993 ft. . . . . The substructure comprises the four granite piers which support the channel span and sixteen small cylindrical piers which support the towers which carry the deck spans. These four piers are built on pneumatic caissons.

Pier	I.	is	53	ft.	long,	25 ft. wide and	18 ft. high.
"	II.	"	55	"		27 " "	18 "
"	III.	"	55	"		27 " "	18 "
"	IV.	"	53	"		25 " "	30 "

Full information of the sinking of these foundations, and elaborate tables of their cost and that of the masonry, are given. The cost, including freight on materials, for the four piers and their foundations was as follows:

Foundations	$220,742.75
Masonry	121,274 62
Total	$342,017.37

Average cost of masonry per yard, $30.49.

The superstructure consists of three through spans and six deck spans, three at each end. Each through span is 375 ft. long between centers of end pins, 50 ft. deep and 22 ft. between centers of trusses. Expansion is provided at the west end of every span—that is, at the upper end—the bridge being on a grade.

Each deck span is 125 ft. long between centers of end pins, 17 ft. 6 in. deep, the trusses placed 12 ft. between centers. The spans are separated by iron towers 25 ft. long, thus making each set of deck spans with intermediate towers a continuous structure 425 ft. long, divided into 17 equal panels of 25 ft. each.

The total cost of the bridge was $1,020,384.75.

Specifications for the masonry, daily record of progress in sinking caissons, time, cost and materials used in foundations, and specifications for superstructure are given in full. This descriptive matter is followed by a full-page map showing the location of the bridge; a general elevation, plan, profile and alignment of it; a profile of stratification on bridge line; five full-page lithographs showing the design and construction of the caissons and piers; a diagram showing rate of progress in sinking caissons and another showing record of water-stage of the Missouri River during the construction of the bridge. These are followed by detailed illustrations showing the clay hoist used in laying the foundations, and a full-page lithograph showing the approach piers. Ten full-page illustrations are given representing the construction of the superstructure, and the interesting volume concludes with a map and section of a dyke which was built to protect part of the structure.

The printing, paper and illustrations are admirable, and altogether the volume is a model for reports of this kind.

NEW PUBLICATIONS.

CHALLEN'S ENGINEERS' LOG BOOK. *Daily Runs for the Year.* (New York; Howard Challen. Price, 75 cents and $1.)

CHALLEN'S ENGINEERS' DAILY REPORT. (New York; Howard Challen.)

Every one who has run an engine, whether stationary or marine, knows the convenience and importance of keeping a record of the performance of his engine from day to day, so that he can refer back and see how it has run at different times and under different circumstances. Such a record not only gives him a means of making useful comparisons, but will serve to show whether his engine is doing the work it ought to, and whether the methods which he is following are the best and most economical. The Log Book, which Mr. Challen has prepared and presented seems to fill all the requisites of this kind. It has, in a size convenient to carry in the pocket if necessary, or to keep in any handy receptacle about the engine-room, a page for every week in the year, each page being ruled for seven days. The headings in the table give, besides the date, the Average Pressure, per gauge; Hours Run; Revolutions; Vacuum, per gauge; Piston Speed, in feet per minute; Indicated H.P.; Initial Pressure, per indicator; Terminal Pressure; Temperature of Hot Well; Temperature of Heater; Water per H.P., in pounds; Fuel Burned, in pounds; Ashes; Oil Used; Waste Used. One blank column is left, and the page facing the table is also left blank in order that any remarks as to special conditions, etc., may be entered. With this book the engineer can make up his record in a few minutes each day and with very little trouble to himself. The headings seem to cover everything that is necessary, and a reference to any preceding page will at once give a comparison between the performance of the engine on any two given days, weeks, or other periods of time which may be chosen. The book is so arranged with blank dates that the record may be begun at any time during the year. It is at once a saving arrangement and a diary which ought to be a necessity to every careful engineer.

The Daily Report is a somewhat similar blank, but is made in pad form, so that it can be filled out, torn off and handed to the proper person. It is arranged to take in one day only, but has blanks for six engines on each sheet, so that if more than one engine is employed separate entries can be made for each. The headings on this report are: Time of Start; Time of Stop; Hours Run; Revolutions; Vacuum; Receiver Pressure; Indicated H.P.; Temperature of Room (four times daily); Temperature of Water (four times daily); Water per H.P., in pounds; Fuel Burned, in pounds; Ashes; Engine Oil Used; Cylinder Oil Used; Waste Used. Where a report of this kind is required from the engineer this blank seems to cover all necessary points.

PHOTOGRAPHIC MOSAICS. *An Annual Record of Photographic Progress:* Edited by Edward L. Wilson. (New York; Edward L. Wilson. Price, paper, 50 cents; cloth, $1.)

Interest in photography is no longer confined to a few professionals. The use of the camera has become so common that any work of this kind should command a large number of readers. Engineers should perhaps be considered more than amateurs, since many of them find the camera not merely an amusement but a very useful assistant in their work. Mr. Wilson's Annual is a collection of short chapters showing the progress made in photography during the year, giving notes of new methods, hints to beginners, and other useful matters. How much is to be said on this subject is shown by the fact that the Annual contains 288 solidly printed pages, about one-third of which are occupied by the Editor's account of the progress of the year, the remainder being filled up by short chapters by different authors, both amateur and professional, on a great variety of subjects. The beginner will find here much matter to help him over his difficulties, while the expert will doubtless gather many useful hints.

ALMANACH DER KRIEGS-FLOTTEN (*Naval Almanac*), 1891. Prepared by the Editors of the *Mittheilungen aus dem Gebiete des Seewesens* (Vienna; Gerold & Company).

As in previous issues, this little book is a storehouse of condensed information, and it is really difficult to see how more facts in relation to the navies of the world could be packed into the same space. We find in it a number of tables useful to naval officers and engineers; a brief account of the artillery

adopted by different nations; a navy list for all the nations of the world; and 134 sketches or diagrams of armored ships, showing the leading types thus far brought into use.

The United States does not fill a very large space in the lists, but it is gradually growing, and we find that all our ships, whether completed or under construction, are carefully recorded, with brief descriptions of their general character. In the sketches we are represented by the *Maine*, the *Texas*, the *Puritan*, the *Terror* and the three new battle-ships.

Judging from the examinations and comparisons which we have been able to make, the work on this book has been most carefully and thoroughly done, and it will certainly be a most useful companion to a naval officer.

FIRST LESSONS IN METAL WORKING: by Alfred G. Compton, Professor of Applied Mathematics in the College of the City of New York. (New York; John Wiley & Sons. Price, $1.50.)

This book has been prepared by Professor Compton with the purpose of making it what its title indicates, and in making it he has been guided by his experience while in charge of the workshops attached to the City College and the course in the Manual Labor Department of that institution. The different chapters, or lessons, as they are called, are on Metal Working Tools for Wrought and Cast Iron; the Different Processes in Blacksmithing; Foundry Work; the Properties of Wrought Iron and Steel; the Methods of Working Steel; Chipping, Drilling, Filing and Soldering Metal. The Author's purpose and methods in making up the book can perhaps best be explained from an extract from his preface:

The first year of instruction in handicraft, as experience in the College of the City of New York has shown, may be given to wood-working or metal-working with about equal advantage. The minute accuracy, the acquaintance with geometrical construction, and the habits of neatness and cleanliness which are essential in the one, are offset by the judgment, forethought, and artistic freedom of the other. Both constantly teach the lesson of orderly procedure, careful attention to instructions, and, where a text-book is used, of minute and thoughtful reading, such as takes in the full significance of every proposition and every limitation of it. The feeling of good fellowship which results from struggling with the same difficulties, and occasionally, as in wood-working, and still more frequently, as in forge-work, lending a helping hand to each other, is a valuable part of the product of workshop training in either department. It has been the Author's practice therefore, for some time, to let a portion of each class begin in the wood-working shop, and another in the forge and vise-room. The advantage is thus secured of having both shops well filled; while otherwise, as the second year's class is always smaller than the first, one shop is overcrowded at the same time that the other is perhaps not more than half full.

The book being intended more for those who are acquiring a general education than for those who are learning a special trade, more time and space have been given to the development of the processes of manufacture of metal in their proper order than to the details of special work. As an assistant in a course of this kind it seems to be an excellent handbook for the student.

TRADE CATALOGUES.

Catalogue: Frogs, Switches, Crossings, etc. The Weir Frog Company, Cincinnati, Ohio.

In the preface the Weir Frog Company announces that the present is its first catalogue, as its custom heretofore has been to send blue-prints, photographs, etc., as occasion required. The excellence of the book, therefore, must be the result of good judgment rather than of experience, for from almost every point of view it is a very good one. In the first place, it is well printed and of convenient size, with a page still large enough not to cramp the engravings. The illustrations are clear and good, and the descriptions are generally condensed, but yet sufficient to give, in connection with the drawings, a clear idea of the different devices. There is hardly a line of superfluous matter in the book, which must be considered very high praise.

The catalogue shows a number of patterns of switches and fittings; of frogs and of crossings, the latter including crossings of street as well as of steam railroads, and one pattern which is entirely new, a crossing of a steam railroad and a cable railroad, where some ingenuity is required to carry the rails over the cable conduit without interference.

The Pintsch System of Car Lighting by Compressed Oil Gas: the Safety Car Heating and Lighting Company, New York.

This pamphlet consists chiefly of a list of the roads on which the Pintsch system of lighting cars has been adopted, and of letters from officers of some of those roads, testifying to its success.

Trinidad Asphalt Street Pavement; The Warren-Scharff Asphalt Paving Company, New York.

The use of asphalt for street pavements is gradually increasing, and some information about the subject will be welcome to many who are interested in the paving question. This information is given in the four pamphlets issued by the company named above and included in the general title. Perhaps it would have been better if a little less space had been given to the description of the source from which the material is obtained, and a little more had been said of the behavior of the pavement under wear. No one doubts that asphalt pavement has many excellent qualities, and the main question has been as to its ability to stand under heavy traffic. Some particulars on this point are given, it is true, but more would be desirable.

Catalogue of Injectors, Steam and Check Valves, etc.; Rue Manufacturing Company, Philadelphia.

Joy's Valve Gear; Illustrated Circular: David Joy, London, England.

The Roney Mechanical Stoker and Smokeless Furnaces: Illustrated Description. New York; Westinghouse, Church, Kerr & Company, Engineers.

Open-hearth Steel Castings: the Sharon Steel Casting Company, Sharon, Pa.

Illustrated Catalogue of Improved Hydraulic Jacks: Watson & Stillman, New York.

BOOKS RECEIVED.

On Steel Rails, Considered Chemically and Mechanically: by Christer P. Sandberg. London, England; reprinted from the *Proceedings* of the Institution of Mechanical Engineers.

Official Railroad Map of Nebraska: Compiled by the State Board of Transportation. Lincoln, Neb.; published by the Board of Transportation.

The Taylor Iron Works Diary for Railroad Men, for 1891. High Bridge, N. J.; the Taylor Iron Works. This is the new number of the very neat and convenient pocket diary which this company has issued annually for a number of years past.

Cornell University Register, 1890–91. Ithaca, N. Y.; published by the University.

Cornell University, College of Agriculture: Bulletin of the

Agricultural Experiment Station. XXIII, December, 1890. Ithaca, N. Y.; published by the University.

Institution of Mechanical Engineers: Proceedings, July, 1890, *Sheffield Meeting*. London, England; published by the Institution.

Information Required for the Designing of Structural Iron and Steel Work: by F. Stuart Williamson. New York; published by the Author.

Report of Committee on Coke Iron Manufactures for the City of Marquette. Marquette, Mich.; the Citizens' Association.

Reports of the Consuls of the United States to the State Department: No. 121, *October*, 1890. Washington; Government Printing Office.

Refrigerators and Food Preservation in Foreign Countries: Special Consular Reports to the Department of State. Washington; Government Printing Office.

Air-Brake Rigging; its Character, Maintenance and Operation: by R. A. Parke, M.E. New York; published by the New York Railroad Club. This is a reprint of an excellent paper read by Mr. Parke at the December meeting of the New York Railroad Club.

Irrigation in India: by Herbert M. Wilson, C.E. New York; reprinted from the *Transactions* of the American Society of Civil Engineers.

ABOUT BOOKS AND PERIODICALS.

THE articles on Southern California, by Mr. Charles Dudley Warner, are continued in HARPER'S MAGAZINE for January. The South American paper by Mr. Child in this number is on Peru, describing his general impressions of the country and its present material condition.

In the POPULAR SCIENCE MONTHLY for January Mr. Durfee's article on the history of Iron Manufacture in America is continued by a chapter on Iron Mills and Puddling Furnaces. Professor Samuel Sheldon has an interesting article on the storage of Electricity. Among the other articles given are a paper on the Decline of Rural New England, by Professor A. N. Currier, and M. Armand de Quatrefages' discourse on the Peopling of America.

In its issue for January 3 the ENGINEERING AND MINING JOURNAL gives statistics of the mining industries of the United States which make it a very valuable number for present reading and for reference.

The leading articles in the latest quarterly number of the PROCEEDINGS of the United States Naval Institute are on the Protection of the Hulls of Vessels by Lacquer, by Lieutenant J. B. Murdock; a Study of the Movements of the Atmosphere, by Lieutenant E. Fournier, of the French Navy; Assistant Secretary Soley's address at the unvailing of the Jeannette Monument; Lieutenant W. F. Fullam's paper on Naval Training and Discipline, and the discussion on that article.

In the January number of BELFORD'S MAGAZINE Henry George, Jr., has a somewhat intemperate article against the increase of the Navy. The other more serious papers are on Interest and Usury Laws, by Frederick T. Jones; on the Lake Region of Wisconsin, by B. P. Legare, and on the Fine Art of Walking. There is the usual variety of fiction and lighter articles, and some sharp and pointed editorial discussion of current affairs.

In SCRIBNER'S MAGAZINE for January there is given the second of Sir Edwin Arnold's papers on Japan. Another article on travel is Josiah Royce's Impressions of Australia—a country about which most of our people know very little. Modern Fire Apparatus, by John R. Spears, is a practical and interesting paper. Mr. William P. P. Longfellow discourses from the Architect's Point of View, giving his ideas in a striking and forcible way.

The difficulty of establishing a new magazine is well known, and makes more remarkable the success which the ARENA has attained in a little over a year. This is doubtless due to the fact that intelligent readers appreciate free and courageous discussion of live questions, for which the new magazine has given an opportunity never before so fully afforded.

The skater, the wheelman, the canoeist, and indeed almost every class of reader, will find something to interest him in OUTING for January. Not only out-door sports, but travel find room in its columns. The military papers, which have attracted much attention, are continued in this number by an interesting article on the Active Militia of Canada, which deserves a careful reading on this side of the line.

The Chattanooga TRADESMAN has made its issue of January 1 a "Census" number, in which is given a great variety of interesting matter concerning the growth of manufacturing enterprises in the South, and the resources of that section. Chattanooga itself is a center of industrial progress, and is well represented by our enterprising contemporary.

The leading article in the January number of the JOURNAL of the Military Service Institution is the prize essay of the Institution for the year; it is by Lieutenant George W. Read, Fifth Cavalry, and is on a Practical Scheme for Training the Regular Army in Field Duties for War. Other articles are on Artillery School Methods, by Lieutenant Hunter; the Marksman's Method of Defeating an Army, by Captain Chester; Strategy, Tactics and Policy, by Lieutenant Bush; the Gyroscope and Drift, by Lieutenant Richmond; Practical Education of the Soldier, by Lieutenant Parkhurst. The historical sketch for the month is of the Eighth Cavalry, by Lieutenant O'Connor.

The JOURNAL will hereafter be edited by Major William L. Haskin, First Artillery, Brevet Brigadier-General T. F. Rodenbough having retired from the position after a service of 12 years, on account of the pressure of other duties. It is largely due to General Rodenbough's experience and judgment that the JOURNAL has attained its present high standing as a service magazine.

FORNEY'S SAFE DEPOSITORY FOR SLEEPING-CARS.

NEARLY every person who has had occasion to travel in sleeping-cars has experienced the nervousness and anxiety which attends the disposition and care of his pocket-book and other valuables during the night. The invention illustrated herewith is intended to afford a receptacle or depository in which small articles liable to be stolen can be locked up for safe keeping. Fig. 1 is a perspective view, showing a section of a sleeping-car provided with two safe depositories *A* and *B* below the windows. Fig. 2 is a transverse section on an enlarged scale through one of these, showing the window recesses below the two sashes, the outside of the car being on the left side of the engraving. The full lines *B C D* represent a half cylinder made of brass, in the position it occupies when the recess or depository is closed. The semi-cylinder has a head at each end. These heads are fastened by pivots *A* to the window-posts, so that the cylinder can be revolved about these pivots from the position shown by full lines *B C D* to that represented by the dotted lines *B C D*. When in the latter position the recess can be used as an arm-rest in daytime, or a receptacle for books and other small articles or packages. Nearly every one who has traveled in sleeping-cars has experienced the discomfort and inconvenience of the small arm-rests ordinarily used in that class of vehicles below the windows. The window recess furnishes a very comfortable arm-rest in the daytime when

Fig. 1.

FORNEY'S SAFE DEPOSITORY FOR SLEEPING CARS.

the half cylinder is turned back into it, as shown by the dotted lines in fig. 2, and as represented at *A* in the perspective view. At *B* the safe depository is shown closed, or in the position it would occupy at night.

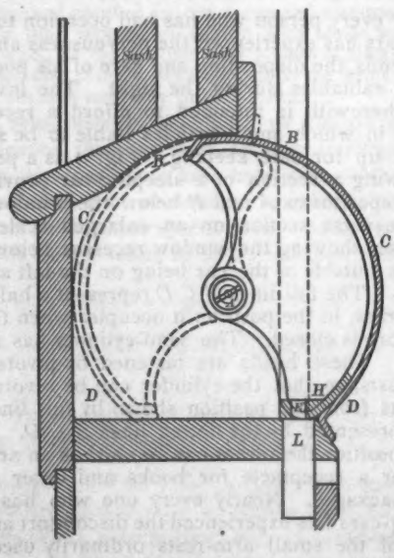


Fig. 2.

In fig. 2 *L* represents a lock which requires the use of two keys to open it. One of these keys is retained by the conductor of the car, and the other is delivered to the passenger. Neither of them can thus open the safe depository without the co-operation of the other, and in case the passenger's key was stolen it would do the thief little good; or if the conductor was disposed to do so he could not unlock the depository without the co-operation of the passenger or procuring his key. *E* is the bolt of the lock which engages with a hasp *H*.

It will be noticed from fig. 2 that the recess below the two sashes is nearly as wide as the whole thickness of the side of the car. Consequently the space *D H* gives an arm-rest over six inches wide. This is equivalent to widening the seat to nearly that extent, as the old arm-rests are not needed when the recess is used, and the passenger can then sit close up to the side of the car without the sensation of being disagreeably crowded, which he feels when there is no suitable rest for his arm.

The receptacle of each of the safe depositories is large enough to take a gentleman's vest or waistcoat, a light coat, or any small package. Locking up his valuables at night gives a pleasant sense of security to a traveler which is conducive to sound sleep and prevents loss by theft, of which most travelers, but especially ladies, are apprehensive when their money, their watches and jewelry are not locked up.

This device is the invention of Mr. M. N. Forney, whose address is at 145 Broadway, New York.

THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

By A. Zdziarski, Engineer.

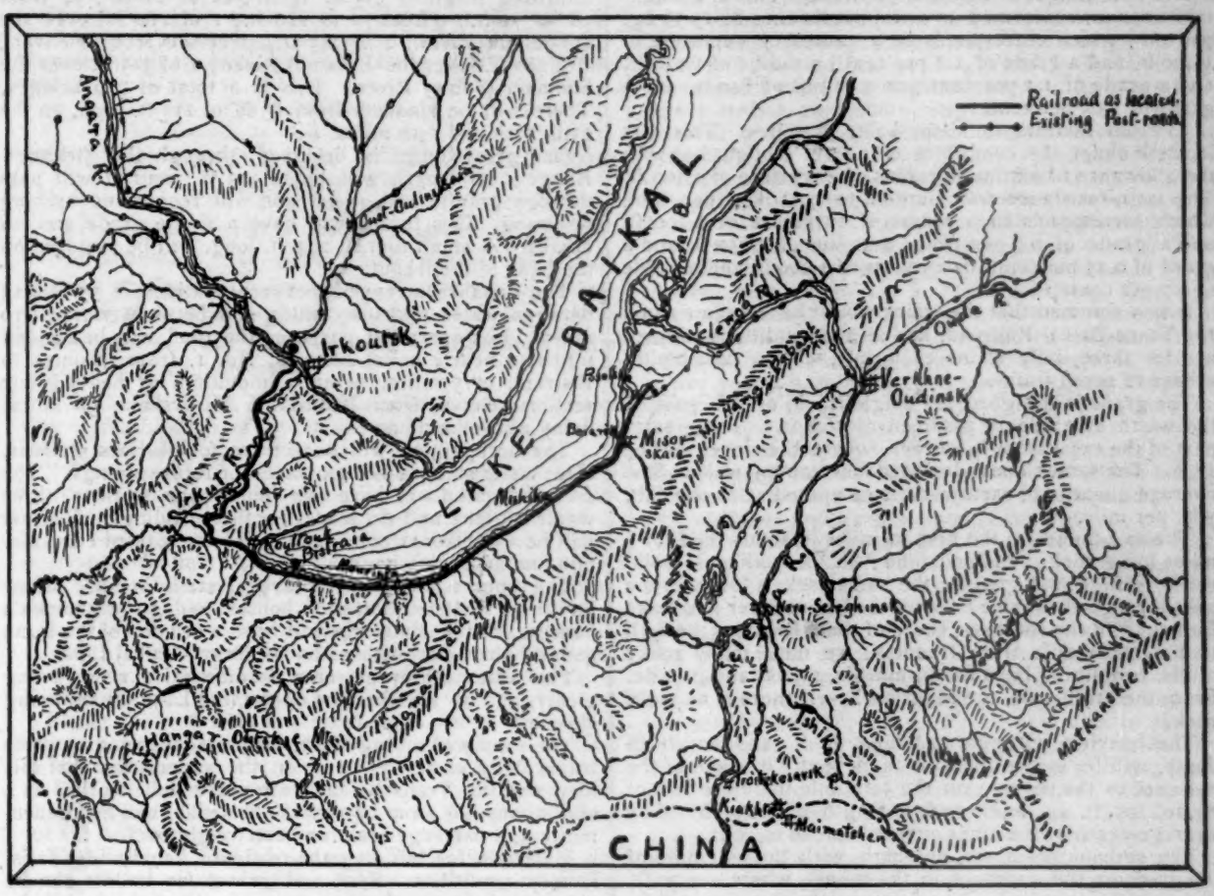
(*Continued from page 27.*)

III.—THE BAIKAL LOOP LINE.

While in the original design of the Great Siberian Railroad the Baikal Loop Railroad was not specified, the many disadvantages presented by the other means of communication between Irkoutsk, the terminus of the Central Siberian Railroad, and the eastern shore of Lake Baikal, only a reconnoissance, was made with the same accuracy as an ordinary survey, instrumental longitudinal and cross leveling being applied to the main line, barometer leveling being used only in the preliminary work.

The general location was governed from the north by Lake Baikal. The shortest line must pass through Koultouk, and go eastward, following the south shore of the lake.

Three different lines were barometrically explored from Irkoutsk to Koultouk, the first following the Irkout River, crossing the Zirkizoun Range through a pass 770 ft. above the lake level and descending the Valley of the Koultoushka River. The other two lines were abandoned, the first, which followed the post road, having, within 6 miles from Koultouk, to cross the sources of the Great Zazara,



BAIKAL LOOP LINE, GREAT SIBERIAN RAILROAD.

or the town of Verkhne-Oudinsk, the proposed starting-point of the Trans-Baikal Line, induced the Government to order the exploration of a connecting line or loop. This was placed under charge of the Chief Engineer of the Trans-Baikal Survey. The disadvantages referred to are briefly stated below.

The period of open navigation from Irkoutsk to Verkhne-Oudinsk—which is on the Selenga River, a tributary of Lake Baikal—lasts only 4½ months, and a transfer of freight would be necessary at the mouth of the Selenga. Navigation from Irkoutsk to the eastern shore of Lake Baikal is open for six months, since the Selenga usually freezes over nearly two months earlier than the lake. In winter there is a good sledge road from Irkoutsk to the eastern shore of the lake for 3½ months, but the sledge road to Verkhne-Oudinsk lasts only one month, on account of the very light snowfall in the Trans-Baikal.

These circumstances made it very desirable that the loop line should be built, and that, at least, the Trans-Baikal Railroad should start from some point on the eastern shore of the lake.

The exploration of the Baikal Loop Line, although called a tributary of the Irkout, at a height of 1,330 ft., requiring a long tunnel; while the other was impracticable for the reason that the western shore of Lake Baikal is very tortuous and presents bluffs 1,200 to 1,400 ft. high, so that even with a radius of curvature of 840 ft., numerous tunnels would be required; moreover, the banks of the Angara are nearly 200 ft. in height and the line would be some 17 miles longer than the first.

The selected line is 83½ miles long from Irkoutsk to Koultouk, and can be built with grades of 1.2 per cent. A tunnel about 2½ miles long, through the neck of a loop or bend in the Irkout River, would shorten the line about 20 miles.

The second part of the line, from Koultouk to the harbor of Misovskaia on the eastern shore of Lake Baikal, which was selected for the starting-point of the Trans-Baikal Line, follows closely the shore of the lake. All the trials to find a suitable pass through the Hamar-Daban Range were unsuccessful. The first route surveyed, starting from the Mourinska River, crossed two divides, the first 4,252 ft. high and requiring grades of 3 per cent., the second divide presenting grades of 5 per cent. Another

route, starting from the Mishika River, traversed the range at a height of 3,354 ft., with grades of 2.5 per cent. Others gave no better result, and none of the passes of the Hamar-Daban were found suitable for a railroad line, so that the lake-shore route was adopted.

The whole length of the located line from Irkoutsk to Misovskaia is 194 miles, and it can be divided into three sections, as below.

1. From Irkoutsk to Moïgot, 62 miles. This is a light mountain section, and the location was made accordingly, assuming the additional train-resistance due to curvature and gradients at 10.50 kilogrammes per ton; which corresponds to a radius of curvature of 1,050 ft. and a grade of 0.8 per cent., or to a radius of 840 ft. and a grade of 0.7 per cent.*

2. From Moïgot to Bistraia, 36 miles. This is a mountain section, conformed to a train-resistance of 13.77 kg. per ton; which corresponds to a radius of curvature of 1,400 ft. and a grade of 1.2 per cent., a radius of 1,050 ft. and a grade of 1.1 per cent., or a radius of 840 ft. and a grade of 1.05 per cent.

3. From Bistraia to Misovskaia, 96 miles. This was located under the conditions of a level section, but with the allowance of minimum radius of curvature of 1,400 ft. The train-resistance was limited to 9.11 kg. per ton; which corresponds to a radius of curvature of 2,100 ft. and a grade of 0 8 per cent., a radius of 1,750 ft. and a grade of 0.75 per cent., or a radius of 1,400 ft. and a grade of 0.7 per cent.

It was assumed that the trains would be the same as on the Trans-Baikal Railroad, and all the conditions adopted are for three daily trains each way, with a possible increase to seven trains.

The grade is designed for single track, of 5 ft. gauge; the width of grade is assumed at 16.8 ft. The greater part of the excavation is in rock, where the slopes will be 1 : 2. The same slope is designed for retaining walls. The average quantity of earthwork is computed at 70,000 cub. yds. per mile.

The soil found on the first 10 miles is sand; then for 8 miles loose rock—red sandstone; on the 30th mile solid rock—granite and gneiss; the same rock is found in the pass through the divide between the Irkout River and Lake Baikal. On the southern shore of the lake, from the 89th to the 119th mile from Irkoutsk, we meet many rocky bluffs, containing lapis lazuli, marble, gneiss and granite. From the 119th mile, the Mourina River, there is no more rock.

The heaviest cuttings, reaching 84 ft. and 105 ft. in depth, will be in the bluffs on the Irkout River and at the entrance to the tunnel; on the 59th mile there are cuts of 70 to 105 ft. in depth and a length of 1,050 ft. The average depth of the other cuts is from 20 to 30 ft.

The embankments are not high, with the exception of the grade on the approach to the tunnel, where one 70 ft. high will be required. The larger embankments will be made with retaining walls of dry masonry, or will be protected by rip-rap.

On the second section, on the descent to Baikal, there are cuttings of 55 ft. in depth, and embankments of stone, 118 ft. high; trestle-work is not considered suitable here, in view of the small radius of curvature, 840 ft.

Some heavy work will also be required in crossing the Kirkidaï Gap, on the 81st mile, where there is one cutting 98 ft. deep, two 38 ft. deep and embankments 42 ft. and 49 ft. high, the former with retaining walls. Some retaining walls will be required on the 96th and 98th miles, on the lake shore, to protect the grade from high waves and from ice.

The Baikal Loop Line, especially in the valley of the Irkout and on the southern shore of Lake Baikal, will require numerous bridges. In all 331 bridges are designed with a total length of 10,234 ft. As a rule these bridges will be of wood, bridges with masonry abutments and wooden or iron superstructure being designed only as exceptions, at points where there is danger from ice.

The greatest bridge will be over the Irkout River, with a clear span of 560 ft. It will have stone abutments with ice-breakers and iron superstructure. Another iron bridge of 140 ft. span will be used over the Pereemna River, on account of the great wave or tidal motion. These two bridges will require 870 tons of iron.

There will be 69 small bridges of 7 ft. span and 9 of 14 ft. span, all of wood on stone abutments. Masonry culverts will be used only in the approach to the tunnel, in descending the eastern slope of the Zirkizoun Range, and in traversing the Kirkidaï Gap. There will be 12 of 7 ft. span and 2 of 14 ft. span.

The other bridges will all be of wood and will be of the following lengths: 135 of 14 ft.; 22 of 21 ft.; 54 from 28 to 70 ft.; 9 from 70 to 140 ft.; 1 of 210 ft., over the Outoulouk River; 1 of 245 ft., over the Mourin River; 1 of 280 ft., over the Baratouï River; 1 of 315 ft. over the Snejnaia (Snow) River. This is a total of 224 bridges. There will be viaducts from 63 ft. to 112 ft. high, on the 75th, 77th and 79th miles.

One great tunnel is designed, through the Zirkizoun Range; its length will be 12,523 ft., and it will pass through granite and gneiss and will require no arching or lining This tunnel will have a single grade and no curves. A small tunnel, 224 ft. long, will be required on the bank of the Irkout.

The distance arranged between stations is 33 miles; between water tanks, 19 miles, and between sidings, 10 miles. For operating purposes the road will be divided into two nearly equal sections, No. 1, from Irkoutsk to Bistraia, 97.5 miles, being a mountain or heavy-grade section; No. 2, from Bistraia to Misovskaia, 96 miles, being a level section.

The first section will have three fourth-class stations, three water stations and six places for future sidings. The second section will have two fourth-class stations, three water stations and six places for future sidings. Bistraia will be a divisional point, and will have a third-class station and an engine-house.

The engine-houses will have 31 stalls in all. Minor buildings include 48 section-houses and 59 watchmen's houses. All the buildings will be of wood and of the same general character as those on the Trans-Baikal Line.

The water supply presents no difficulties, rivers being plenty, and on a great part of the line Lake Baikal being close by.

The supply of rolling stock, calculated for running three trains daily each way, and on the supposition that this loop and the Trans-Baikal Railroad will be worked as a continuous line from Irkoutsk to Sretensk, will be 46 locomotives, 8 passenger cars and 220 freight cars.

Materials for building the road are found under satisfactory conditions. Sand and gravel for ballast can be obtained from the banks on the southern shore of Lake Baikal, and the bluffs in the valley of the Irkout. Stone—chiefly granite—is found on the line from the 98th to the 119th mile, and is nowhere far from it. Timber—cedar, pine, hemlock and larch—is abundant everywhere on the shores of Lake Baikal and in the valley of the Irkout. Clay is found only at a few points; limestone is found also at a few points, and is probably not scarce.

The cost of this line, 194 miles long, is approximately estimated at 24,000,000 roubles, or 123,711 roubles per mile. This cost—about $65,000 per mile—will make it the most expensive section of the Siberian road.

IV.—THE CENTRAL SECTION.

The Central Siberian Railroad, the Baikal Loop Line and the Trans-Baikal Railroad together form a continuous line, connecting the watershed of the Obi with that of the Amour. The total length of this line and its estimated cost is given in the accompanying table.

This line will start from Tomsk on the Tom, a tributary of the Obi, and end at Matakan (Sretensk), on the Shilka, a tributary of the Amour, and will be the heart or core of the Great Siberian Railroad.

The continuation of this railroad will be by the steamboat line, which, starting from Sretensk, follows that river to

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* The formula used for calculating train resistance in kilogrammes per ton is:

$$\text{Resistance} = \left(\text{Gradient} + \frac{0.65}{\text{Radius} - 55 \text{ meters}}\right) 1000.$$

The radius is to be given in meters.

Section.	Length in Miles.	Cost in Roubles.	
		Total.	Per Mile.
Central Siberian Railroad	1,038	69,000,000	66,300
Baikal Loop Line	194	24,000,000	123,700
Trans-Baikal Railroad	663	55,000,000	82,200
Total	1,895	148 000,000	78,100

the Amour, then the Amour to the point where it bends northward, and thence follows up the Oussouri to Grafskaia, which will be the starting-point of the Oussouri Railroad, the last section of the line.

The distance by river from Sretensk or Matakan to Grafskaia is about 1,590 miles; at present the journey requires about 10 days, but this can be shortened if necessary.

(TO BE CONTINUED.)

NATIONAL CONVENTION OF RAILROAD COMMISSIONERS.

THE following circular has been issued by the Committee appointed last year, which consists of Judge Thomas M. Cooley, Chairman; E. W. Kinsley, of Massachusetts; I. A. Spalding, of Kentucky; D. P. Duncan, of South Carolina; and J. P. Williams, of Minnesota. The circular fully explains itself.

At a Convention of Railroad Commissioners held at the City of Washington on the 6th day of March, 1889, the following resolution was adopted:

"*Resolved*, That it is the opinion of the members of this Convention that provision should be made for annual conventions of the Railroad Commissioners of the several States and the members of the Interstate Commerce Commission, to be held at such place as may be agreed upon, with a view of perfecting uniform legislation and regulation concerning the supervision of railroads."

In pursuance of this resolution a Convention was held at the City of Washington, beginning on the 28th day of May, 1890, at which the undersigned were appointed a Committee to call the next Convention.

Under the authority conferred upon them the undersigned designate the 3d day of March, 1891, at 11 o'clock in the forenoon, as the time, and the office of the Interstate Commerce Commission, No. 1317 F Street, Sun Building, in the City of Washington, D. C., as the place for the holding of said Convention.

The Railroad Commissioners of all the States, and any State officers charged with any duty in the supervision of railroads or railroad interests, are respectfully requested to attend. The American Association of Railway Accounting Officers is also invited to meet with the Commissioners, or to send delegates to the Convention, for the discussion of such questions of special interest to their Association as may arise at the meeting.

The undersigned respectfully suggest the following as subjects which may usefully be considered by the Convention:

1. *Railway Legislation:* How harmony therein may be attained.

2. *Uniformity in Railway Accounting:* What further is important to that end.

3. *Territorial Assignment of Statistics of Operation:* Whether this is not practicable, and what principles should control in grouping railway statistics.

4. *Apportionment of Expenses to Freight and Passenger Traffic:* What reasons there are for making such an apportionment, and what rules should be adopted.

5. *Safety Appliances for Railroad Cars:* What legislation, if any, should be had by Congress.

6. *Reasonable Rates:* What are, and the elements to be considered in the determination thereof.

In offering these suggestions it is not intended that they shall be understood as excluding any other topics affecting State and Interstate Commerce which could properly come before and be entertained by such a Convention.

THE PANAMA CANAL.

(From the New York *Times*.)

THE new concession for a canal across the Panama Isthmus, or the extension of the old one under new conditions, was approved by the Colombian Government on December 20. A dispatch from Paris said that it had been accepted and signed by the Liquidator of the bankrupt canal company, but in a later dispatch from the same city, it was stated that the new contract was still awaiting "the ratification of the Liquidator, whose opinion is not hopeful as to the resurrection of the concern." The exact terms of the new concession have not been announced in this country, although Lieutenant Wyse's original proposition and the modifications suggested by the Colombian Government while the negotiations were in progress, together with a very short telegram as to the prominent features of the final agreement, indicate pretty clearly what they are. Lieutenant Wyse's offer was that a new company or the old one reorganized should pay $2,400,000 in eight annual instalments for the land to be used, with $1,000,000 in paid-up shares and $72,000 per annum for the support of a military force. The committee of the Colombian Senate recommended that $6,000,000 should be paid in cash, with $2,000,000 in paid-up shares. The provisions of the bill, as they stood in October, were that the new company should pay $4,000,000, with shares and privileges to the value of $4,000,000, the money to be delivered in five yearly instalments. A telegram from Panama on December 22 reported that under the approved agreement the new company was to pay $2,000,000 in five yearly instalments, $1,000,000 in privileged shares, and the garrison expenses, and was also to pay for the land to be used. Twenty-six months are allowed for the formation of the new company and a resumption of the work.

The available cash assets of the old company in March last were $3,200,000. There were also the company's interest in the railroad, its buildings and machinery on the isthmus, and its unissued lottery bonds, which then had a market value of about $13,000,000, owing to the fact that they had been secured by a deposit with the Crédit Foncier. It seems probable that there could be obtained out of the wreck enough money to meet the conditions of the new concession, but it is necessary also to supply a new company with resources large enough to carry on the work. The old company, by incurring obligations exceeding $400 000,000, obtained $265,938,000. It expended only $156,600,000 of this on the Isthmus. The Commission of engineers sent to the Isthmus by the Liquidator reported that the cost of completing the work with locks would be $180,000 000. Even if a new company could raise the money in any way, it would be necessary to incur obligations amounting to not less than $250,000,000. Thus far there is not the slightest indication that any group of capitalists can be induced to take up the work, nor is there any probability that the money can be procured by popular subscription in France.

The same Commission, assuming that a canal with locks could be made in eight or ten years, estimated that not until four years after the completion of it would the annual tonnage amount to 4,100,000. With traffic charges greater by 25 per cent. than those of the Suez Canal, the income would then permit the payment of only 4 per cent. on the new company's investment, and the interest would not exceed 6 per cent. eight years later. But it does not appear that the proposed canal with locks would permit the passage in a year of more than two-thirds of the quantity of tonnage which goes through the Suez Canal (which was 6,783,000 in 1889), and the Commission reported that the company could not rely upon more than 320 working days in a year, owing to the climate and other conditions. A careful study of the facts and estimates submitted by the Commission does not disclose anything to encourage a syndicate or a new company to take hold of the work. The sum to be invested is too large, the natural obstacles are too formidable, and the possible income would be too

small. Moreover, a competent and trustworthy organization is making another canal in Nicaragua. But Lieutenant Wyse has not procured this extension of the old concession without having in mind some project for utilizing it, and the world will await with some curiosity the development of his plans.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C.E.

(Copyright, 1889, by M. N. Forney.)

(*Concluded from page 14.*)

CHAPTER XXXI.

HOWE TRUSS BRIDGES.

The plans for Howe truss bridges were to be completed in the January number of the Journal; but it has been considered best by the Author to supplement, or rather to complete, them by a design for a long span bridge. This design, which is for a through span of 132 ft., is given in the present number. The plans contained in Plates 129, 130 and 131, with the accompanying bill of material, give all the information required for the engineer. It has not been thought necessary, however, to repeat all the drawings for the smaller castings, and accordingly some references will be found in the list of iron-work, to plates published in previous numbers of the series.

It may be well to repeat here the remark made in some previous chapters, that the kind of wood specified in the bill of material is that which has been most approved by experience for the purpose. It may sometimes be necessary, owing to local circumstances, to substitute some other kind of timber; but in such cases the judgment of the engineer must be exercised in choosing the best timber attainable for his purpose.

No. 53. Bill of Material for Howe Truss Bridge. Through Span, 132 Ft. Plates 129, 130 and 131.

Timber.

No. of Pieces.	Description.	Size.	Length.	Feet B. M.	Kind of Wood.
32	Top Chord.....	7 in. × 12 in.	22ft. 0⅛in.	4,928	Yellow Pine.
8	" "	7 in. × 12 in.	18ft. 6⅜in.	1,040	" "
8	" "	7 in. × 12 in.	7ft. 6⅜in.	424	" "
16	Bottom Chord..	7 in. × 14 in.	44ft. 0 in.	5,760	" "
4	" "	7 in. × 14 in.	41ft. 6 in.	1,358	" "
4	" "	7 in. × 14 in.	30ft. 6 in.	1,000	" "
4	" "	7 in. × 14 in.	19ft. 6 in.	640	" "
4	" "	7 in. × 14 in.	8ft. 6 in.	276	" "
8	Braces.....	12 in. × 18 in.	27ft. 5⅜in.	3,960	" "
8	"	12 in. × 16 in.	27ft. 5⅜in.	3,520	" "
8	"	12 in. × 14 in.	27ft. 5⅜in.	3,080	" "
8	"	10 in. × 12 in.	27ft. 5⅜in.	2,200	" "
8	"	11 in. × 12 in.	27ft. 5⅜in.	2,920	" "
8	"	8 in. × 12 in.	27ft. 5⅜in.	1,760	" "
20	Counters.....	8 in. × 10 in.	27ft. 5⅜in.	3,664	" "
4	"	8 in. × 10 in.	15ft. 0 in.	400	" "
2	Laterals.....	6 in. × 8 in.	21ft. 6¾in.	172	" "
4	"	6 in. × 8 in.	19ft. 8 in.	315	" "
12	"	6 in. × 8 in.	17ft. 3⅜in.	832	" "
2	"	8 in. × 8 in.	21ft. 6¾in.	231	" "
16	"	8 in. × 8 in.	17ft. 3⅜in.	1,488	" "
4	"	8 in. × 8 in.	20ft. 4¾in.	436	" "
2	"	6 in. × 8 in.	13ft.11¾in.	112	" "
2	"	8 in. × 8 in.	13ft.11¾in.	150	" "
38	Floor-beams....	9 in. × 16 in.	19ft. 4 in.	8,816	" "
6	Stringers.....	6 in. × 12 in.	138ft. 0 in.	4,968	" "
118	Ties.....	8 in. × 8 in.	12ft. 0 in.	....	Oak.
2	Guard-rails.....	6 in. × 6 in.	138ft. 0 in.	828	Spruce or Pine.
16	Bolsters.....	7 in. × 12 in.	9ft. 0 in.	1,008	Yellow Pine.
16	Bridge-seats....	7 in. × 12 in.	6ft. 0 in.	672	" "
4	Sills.....	12 in. × 12 in.	19ft. 4 in.	928	Spruce or Pine.
4	Planks.....	2 in. × 8 in.	138ft. 0 in.	736	" " "
8	Blocks.....	2 in. × 8 in.	2ft. 8 in	28	Oak.

Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
12	Rods.....	3 in.	28 ft. 10 in.	16	Bolster b'lts	1¼ in.	3 ft. 4 in.
12	"	2¾ in.	28 ft. 10 in.	268	Chord bolts.	¾ in.	2ft 9½in.
32	"	2½ in.	28 ft. 10 in.	56	String'rb'lts	⅝ in.	2 ft. 6 in.
12	"	2 in.	28 ft. 10 in.	32	T'k strg'b'ts	¾ in.	2 ft.10 in.
6	"	1¾ in.	28 ft. 10 in.	76	Fl.beam b'ts	1¼ in.	3 ft. 0 in.
6	Laterals....	1¾ in.	20 ft. 0 in.	80	Tie-bolts...	⅝ in.	2 ft. 6 in.
16	" ...	1½ in.	20 ft. 0 in.	42	G'rd-r'l-b'ls	⅝ in.	1 ft. 4 in.
8	Counters....	1 in.	15 ft. 6 in.	24	Brace-bolts.	¾ in.	2ft.9½in.
16	Bolster b'lts	1¼ in.	12 ft. 4 in.	104	Spikes.....	½ in.	9 in.

Other Iron Work.

Washers (see Plate 120): 44 of pattern *H*; 216 of *G*; 1,100 of *F*.
Castings (see Plate 130): 36 of pattern *A*; 36 of *B*; 8 of *C*.
Castings (see Plate 131): 8 of pattern *A*; 36 of *B*; 8 of *C*.
Castings (see Plate 133): 8 of pattern *B*.
Castings (see Plate 134): 4 of *B*—end brace-block.
Castings (see Plate 117): 8 of pattern *F*; 112 of *I*.
Castings (see Plate 121): 192 of pattern *L*; 196 of *M*; 80 of *O*; 40 of *P*; 80 of *Q*.

RAILROAD ACCIDENTS IN GREAT BRITAIN.

The returns of accidents and casualties, as reported to the Board of Trade by the several railway companies in the United Kingdom, during the six months ending June 30, 1890, which has at length been published, exhibits a considerable decrease in the number of passengers killed and injured as compared with the corresponding period of last year, which is mainly due to the fact of the Armagh disaster having occurred in the first half of the year 1889.

The total number of personal accidents reported during the six months amounts to 499 persons killed and 5,108 injured. Of these, 51 passengers were killed and 673 injured; railway servants killed, 231; injured, 4,232; other persons (trespassers, suicides, etc.), 217 killed and 203 injured.

During the half-year 55 collisions between trains took place in which persons were either killed or injured. These are distinguished as to their nature and results in the following manner.

Eleven collisions between passenger trains, or parts of passenger trains, by which 22 passengers and one servant were injured; 32 collisions between passenger trains and goods or mineral trains, etc., by which five passengers and two servants were killed, and 80 passengers and 26 servants injured; 12 collisions between goods trains or parts of goods trains, by which one passenger and one servant were killed and two passengers and 14 servants were injured.

There were reported 363 failures of tires, of which 9 were on engines, 4 each on tenders and carriages, 10 on break vans, and 336 on wagons, 259 of which belonged to private owners. Of these tires 302 were of iron and 61 of steel; 17 of them broke at rivet holes, 1 at the weld, 70 in the solid, 272 split longitudinally or bulged, while 3 that tailed did not break.

The failures of axles numbered 132, of which 75 were on engines (67 being driving and 8 leading or trailing axles), 5 were tender axles, 4 carriage axles, and 48 wagon axles (3 being on salt wagons, and 16 of the wagons belonging to private owners). Of the 67 driving axles, 28 were made of iron and 39 of steel; the average mileage of 25 of the iron axles was 184,915 miles, and of 36 of the steel axles 209,941 miles.

The breakage of 115 rails is reported, of which 44 were double-headed, 60 single-headed, 1 bridge pattern, and 4 Vignoles' pattern. Twenty-five of the double-headed rails have been turned. Of the total number of rails that broke, 108 were of steel and 7 of iron.

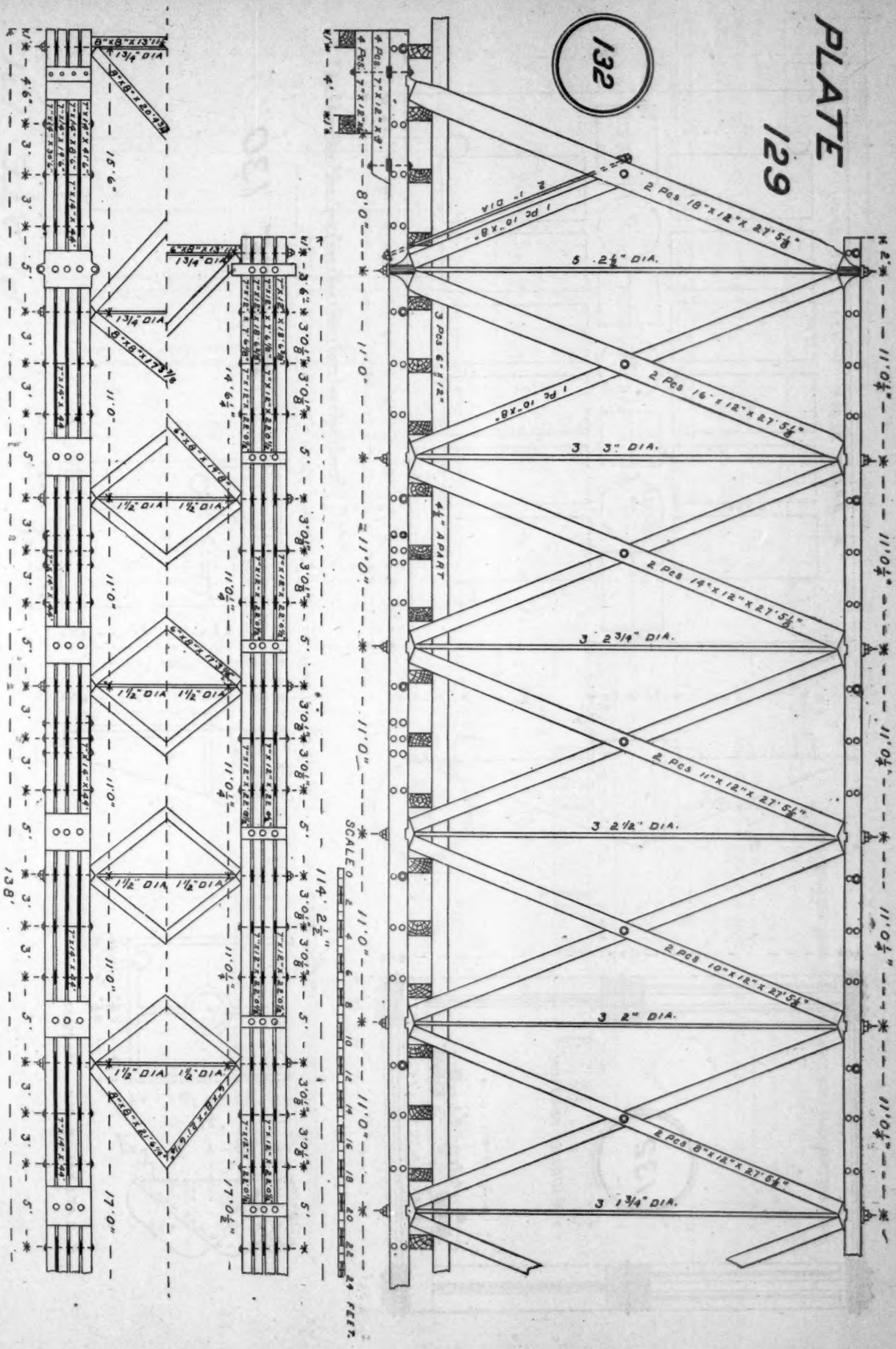
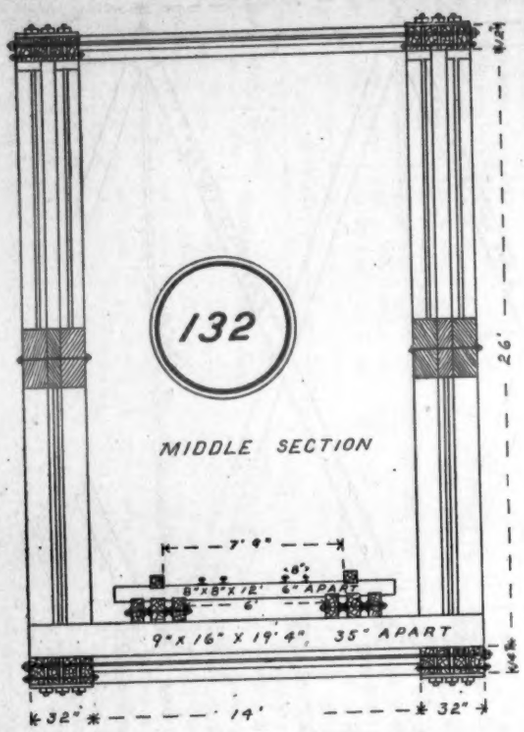
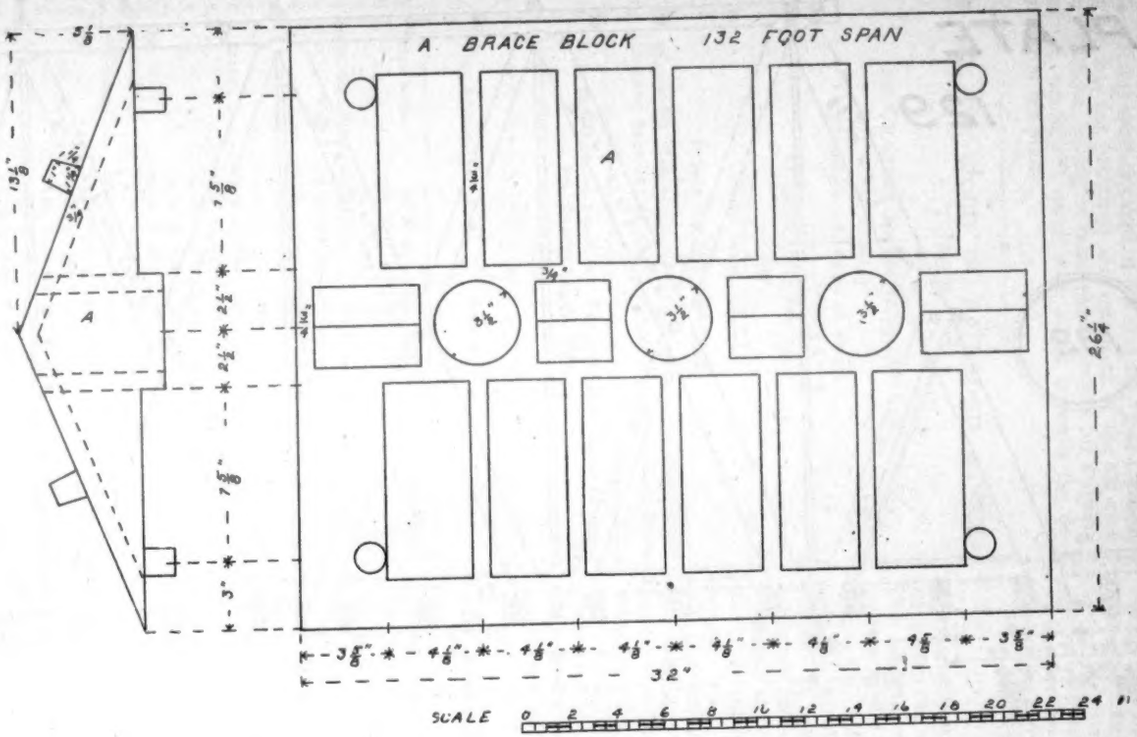
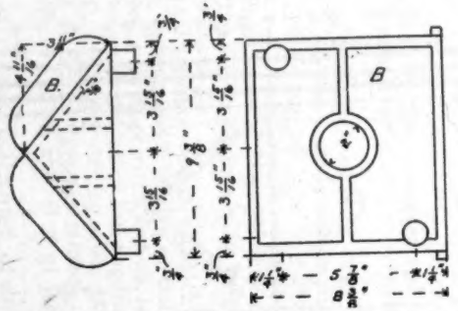


PLATE 129
132
2 Pcs 18"x12"x 27'-5½"
5 .2½" DIA.
2 Pcs 16"x12"x 27'-5½"
3 3" DIA.
2 Pcs 14"x12"x 27'-5½"
3 2¾" DIA.
2 Pcs 12"x12"x 27'-5½"
3 2½" DIA.
2 Pcs 10"x12"x 27'-5½"
3 2" DIA.
2 Pcs 8"x12"x 27'-6¼"
3 1¾" DIA.
3 Pcs 6"x12"
4½" APART
1 Pc 10"x8"
2 1" DIA
SCALE
FEET


132
MIDDLE SECTION
7' 0"
6"
8"X8"X12' 6" APART
6'
9"X16"X19'4", 35" APART
26'
32"
14'
32"


A BRACE BLOCK 132 FOOT SPAN
A
A
32"
SCALE 0 2 4 6 8 10 12 14 16 18 20 22 24 Ft.


B.
B
B. LATERAL BLOCK 132 FOOT SPAN

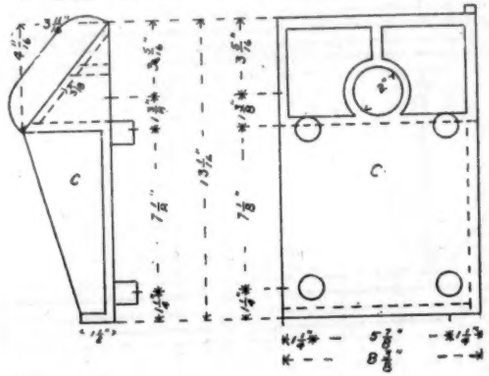
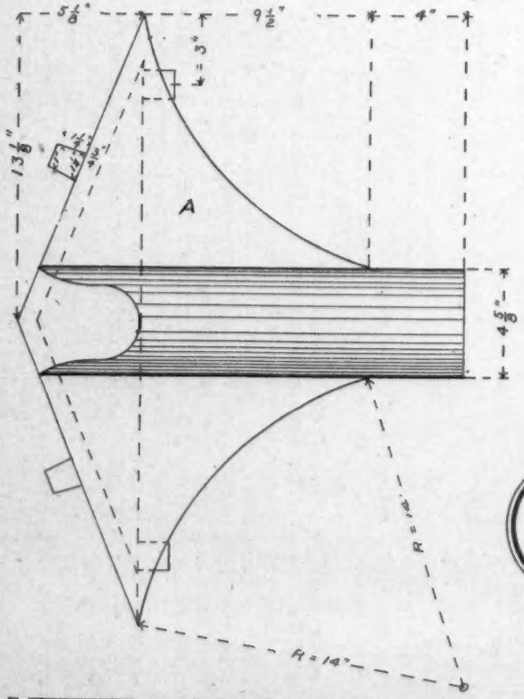

C END LATERAL BLOCK 132 FOOT SPAN.
C
C

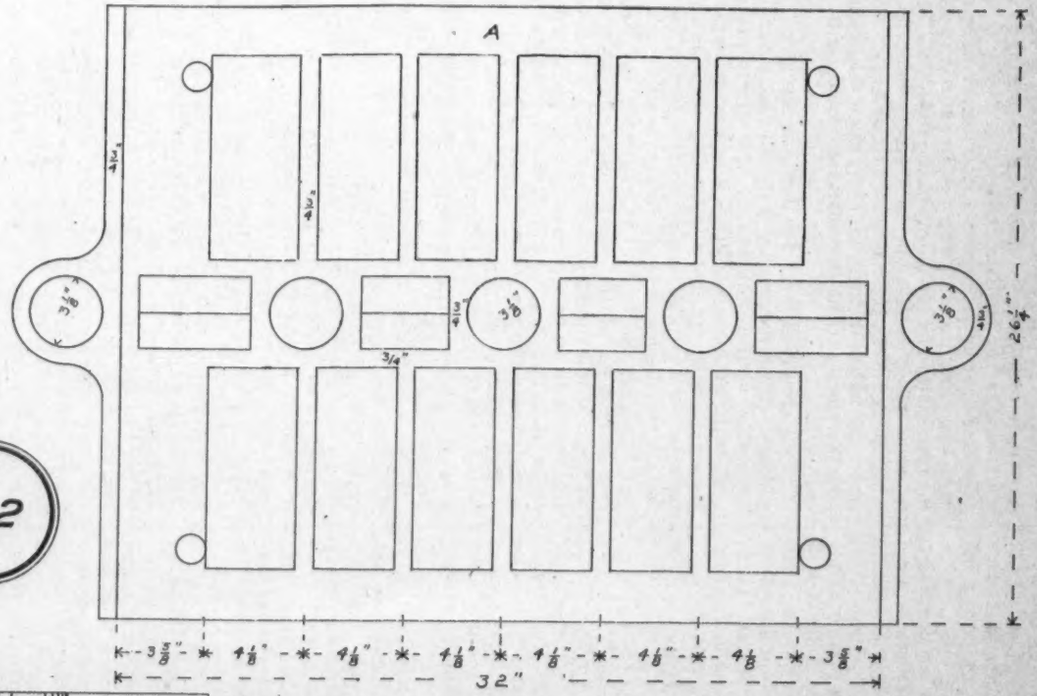
PLATE 130

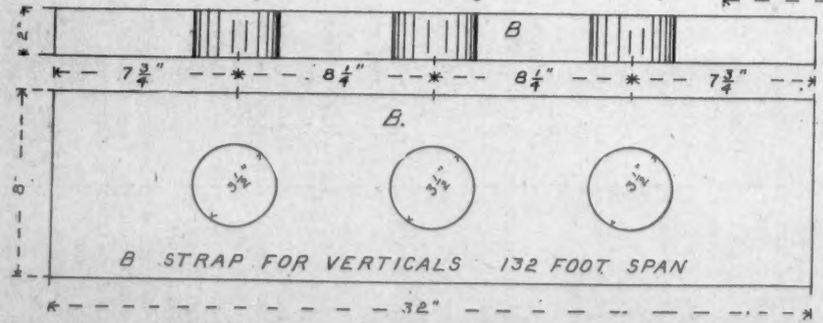
PLATE 131

A BRACE BLOCK FOR END VERTICALS 132 FOOT SPAN



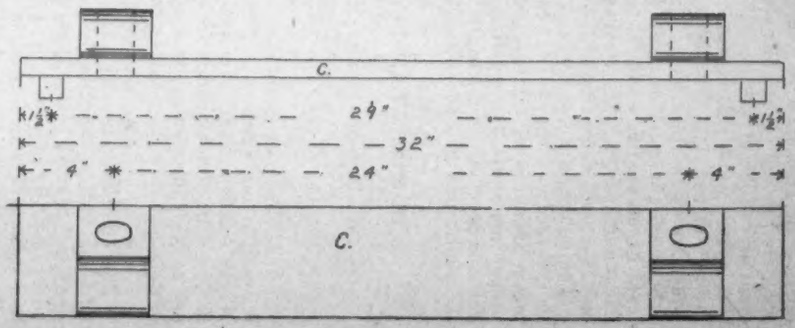
132





B STRAP FOR VERTICALS 132 FOOT SPAN

C. STRAP FOR END BRACE RODS 132 FOOT SPAN



SCALE 0 2 4 6 8 10 12 14 16 18 20 22 24 IN.

Of the 254 persons killed and 490 injured from causes other than accidents to trains, rolling stock, permanent way, etc., including accidents at level crossings and from want of caution or misconduct, 44 of the killed and 378 of the injured were passengers, and mostly met with their injuries in entering, leaving the carriages, or falling between trains and platforms.

Seventy-four persons met their deaths at crossings, level or otherwise, while 33 others were injured at those dangerous places; 117 trespassers were killed, and 33 others committed suicide on the lines during the six months.

Taking the return as a whole, it is not one that redounds to the credit of the railway companies, as it exhibits so many instances of their neglect to provide sound and proper materials and appliances, or to adopt the fullest possible precautions to ensure immunity from accident to the public and their servants.—*Railway Herald, London.*

OUR NAVY IN TIME OF PEACE.

By Lieutenant Henry H. Barroll, U. S. N.

(*Continued from page 22.*)

There are two main institutions for the professional training of the *personnel* of the United States Navy—the Naval Academy and the Training School; the former for the education of commissioned officers and the latter for naval apprentices, who afterward become warrant officers, petty officers, and seamen.

THE NAVAL ACADEMY.

The United States Naval Academy is situated at Annapolis, Md. The site is a healthful one, the surrounding country being slightly rolling, while the Severn River, near its entrance into Chesapeake Bay, furnishes a fine stretch of water, suitable for boat-sailing, etc., and affords to the practice vessels a safe and convenient harbor. These vessels lie either alongside or near the wharves, thus allowing opportunity for sail and spar drill at all seasons of the year.

Here, since 1845, have been educated all Line Officers of the Navy; and in conformity with a law recently passed by Congress, vacancies in the Engineer, Construction and Marine Corps are now also filled by graduates from this institution. Surgeons, paymasters and chaplains are now the only commissioned officers who are appointed directly from civil life.

There are two ways in which admission to the Naval Academy may be obtained—appointment either by a member of Congress or by the President of the United States.

Each member of Congress or territorial delegate is entitled to have continuously at the Naval Academy a cadet representing that district or territory. There are allowed, also, to be continuously represented upon the academic rolls, ten cadetships "at large," and all appointments to fill vacancies which may occur among these are made by the President of the United States, who also has the appointing of the cadet representing the District of Columbia.

The academic course extending over six years, it will thus be seen that except for failure on the part of the candidate to pass the successive examinations, both Congressional and Presidential appointments would only ensue every sixth year; but there are vacancies occurring in these cadetships all along the line of the academic course, owing to resignations, dismissals, or failures to pass the regular examinations.

Whenever, through any cause, a vacancy occurs in the representation of a Congressional district or Presidential appointment, the member of Congress, delegate, or the President is notified of the fact by the Secretary of the Navy, and is requested to designate the person whom he may desire to have appointed on probation.

Of late it has become a custom for members of Congress to issue a call for a competitive examination among the students of the public schools of that district to which the vacancy belongs, and to award the appointment to the successful competitor; but this is by no means obligatory, and the law allows him to appoint any particular person he may choose to designate, without holding such competitive examination. The candidate nominated, however, must be over 15 and under 20 years of age, of good physique, fairly sized according to his age, and not afflicted with any bodily infirmity.

In case that by July these appointments have not been made by those persons who are authorized to designate the candidates, the law allows the Secretary of the Navy to fill them when application for them is made by any one who can in all respects satisfy the requirements for admission; the appointments, however, are much sought after, and therefore such a circumstance would be of rare occurrence.

The Secretary of the Navy, being in receipt of the name and address of the person designated as a candidate for admission, notifies him when and where to present himself for the examination which is necessary preliminary to his acceptance; for, notwithstanding that the cadet may have passed a most successful examination in competition for the appointment, he is yet required to show before the Academic Board of Examiners that he possesses a fair knowledge of the rudimentary branches—reading, writing, arithmetic, grammar, history, and geography. He must also be here physically examined, to prove that he is of sound health and robust constitution, before being admitted to the Academy as a student.

This entering examination, which takes place at the Naval Academy, is not a severe one to any youth of 15 years of age who has progressed even moderately well in his studies.

Having succeeded in passing the entering examination, the candidate is given a warrant, signed by the Secretary of the Navy, appointing him a Naval Cadet on probation. He is now allowed a salary of $500 a year and one ration, the latter being commuted at the rate of 30 cents per day, thus making a total of $609.50 annually. From this sum he is required to provide himself with board, clothing, books, washing, and all other necessary expenses. His accounts are retained in the hands of the Paymaster of the Naval Academy, and all articles purchased must be subjected to the approval of the Commandant of Cadets, and drawn on requisition, from the Government store. He is allowed to draw from his accounts, monthly, the sum of one dollar as spending money, and parents and guardians are requested not to furnish the cadets with additional funds. The object of this is to place all of the cadets on the same financial basis, and the effect of it is to avoid that reckless extravagance which is so often characteristic in college students.

From his yearly allowance there is retained, at the rate of $5 monthly, the sum of $60, which is termed "Reserved Pay," and which is paid over to the cadet, at the time of his leaving the Academy, that he may thus be sure of having the necessary means for providing himself with a sea-outfit when starting on service afloat.

The system of education as here pursued may be said to be almost a perfect one, and it has the merit of combining physical with mental training.

The entire course comprises six years, two of which are passed at sea, after a term of four years' study at the Academy. The entering cadet is termed a Fourth Class-man.

The final examination, at the end of this six years' course, if successfully passed, entitles the cadet to a diploma, but does not necessarily assure his being retained in the Naval service. According to a recent law of Congress, from each graduating class there shall be retained annually at least 15 cadets. Of these, 12 shall become Line Officers, two Engineers, and one a Marine Officer. In addition, there must also be kept as many of that class as will make the total number retained equal to the vacancies that have occurred in the several available corps during the preceding 12 months. In this way it may sometimes occur that an entire class of graduates will be retained, provided that the Navy, during the preceding year, has experienced that peculiarly sad fate so vividly portrayed in the Middie's toast, "A bloody war and a sickly season."

In case that the graduated cadet does not take a place sufficiently high in his class to fall within the number allowed to be retained for that year, he is honorably dis-

charged from the Naval service, and is allowed the sum of one thousand dollars with which to start in civil life.

The successful cadet, who takes a position within the number allowed, is at once promoted to the grade of Ensign, Assistant Engineer, or Second Lieutenant in the Marine Corps, the higher numbers in the class being allowed as far as possible to select the corps to which they shall be assigned. These naval grades correspond to that of Second Lieutenant in the military service. It will be noticed that this rank is attained in the Navy only after six years of service, while in the Army it is secured after a term of four years.

Vacancies in the Corps of Naval Constructors are filled by graduates of the Naval Academy, but only after these have been selected to serve a two-years' post-graduate course, that they may especially fit themselves for this duty. They are then appointed assistant constructors, and rank as naval lieutenants, junior grade, or with first lieutenants in the army.

The life of a naval cadet at the Academy is a busy one, and it is a mistake for any but youths of fine physique and strong determination of character to enter for the course. The study and work are exhausting, and often, after having pursued the course for some years, a candidate is rejected owing to a want of the physical force necessary to keep up with his class. It is in most cases not the brilliantly entering candidate who is finally successful in attaining the Ensign's commission, but the youth who enters possessed of strong perseverance and a determination to master the numerous and varied subjects which go to make up the academic course.

The curriculum comprises :

Seamanship, naval tactics, naval construction ;

Ordnance and gunnery (manufacture and use of guns, projectiles, armor, torpedoes, gunpowder, gun-cotton, fulminates, etc.);

Astronomy, navigation and surveying ;

Steam Engineering ;

Mathematics (arithmetic, algebra, plane, spherical, analytical, and descriptive geometry, trigonometry, differential and integral calculus) ;

Physics and chemistry (light, heat, magnetism, galvanism, electricity, etc.) ;

English studies (geography, grammar, history, rhetoric, composition, international law) ;

Modern languages (French and Spanish) ;

Physiology and hygiene ;

Sketching, topographical and mechanical drawing.

The drills and exercises consist of :

Naval tactics manœuvring ship, battalion, company and skirmish drill, boat-sailing, rowing, sail and spar exercises, light and heavy artillery fencing, swimming, boxing, dancing and athletics.

The time allowed for study and for drill is perfectly systematized, and is about the best method that could be devised for combining manual and mental training.

Each academic year is divided into two terms—one extending from October to February, and the other from February to June. At the close of the annual examinations, which are generally finished during the first week in June, the members of the undergraduate class are allowed to proceed to their homes for a short leave of absence, prior to being ordered for two years' sea-service aboard regularly commissioned vessels.

The newly promoted First and Third Classmen are sent to sea on a practice cruise, which each year extends through the months of June, July and August. The Second Classmen are required to remain at the Academy for the greater part of this time, in order that they may have exercise in Machine-shop work ; but all are allowed leave during the month of September to visit their homes—the three classes returning to Annapolis in time for the opening of the succeeding academic year, on or about October 1.

During these summer cruises ample opportunity occurs for exercise aloft at sail or spar drill, in all kinds of weather. The cadets are also taught to reef, steer, work the guns, heave the lead, and to practically navigate the vessel.

The undergraduate class, who have finished their four years' term of study at the Academy, now proceed to sea, being distributed among the several squadrons ; and at the end of two years are again ordered to Annapolis for a final examination, which determines not only whether they shall remain in the Naval service, but also establishes the relative rank of those so retained.

The various duties connected with the superintendence, instruction and drill of the Corps of Naval Cadets require the services of some 75 regular officers of the Navy, and about 18 Naval Professors.

THE TRAINING SCHOOL FOR NAVAL APPRENTICES.

The school for the training of Naval Apprentices has its headquarters at Newport, R. I. There are several vessels assigned to duty connected with this institution—the *Richmond*, at Newport ; the *Minnesota*, at New York ; the *Portsmouth* and *Jamestown*, as cruising vessels, and one small schooner named the *Wave*.

The mode of obtaining admission to the Training School is simpler than that for entering the Naval Academy. The candidate is required to be over 14 and under 18 years of age, of good physique ; he must come voluntarily, and have the consent of his parents or guardian. A deposition to this effect is taken before a notary public by that person having control of the boy. The candidate, being physically qualified, is regularly shipped, or indentured, to serve the United States Government until he becomes 21 years of age, unless he shall be sooner discharged.

The system of education is entirely different to that pursued at the Naval Academy. This is carefully explained to the candidate before his entrance to the training school ; and that, as the Naval Academy is the only recognized channel-way by which he may expect promotion to the higher grades, if he elects to pursue the apprentice's course, he cannot expect promotion to a commissioned rank, except for special gallantry during war times, when such promotions are allowed.

It would not be fair to allow the students at the Training School to enter with the expectation of becoming commissioned officers, and then afterward require them to compete for their commissions with those who had received the advantages of a course in every way so much superior as is that furnished at the Naval Academy. On the other hand, it would not be reasonable to expect the Government to keep up two such institutions as the Naval Academy for the education of its commissioned officers.

Therefore, the entering apprentice, as well as his parent or guardian, are informed that the rank to which the boy can reasonably aspire is limited to one of those positions represented by a warrant, such as Boatswain, Gunner, Carpenter, Sailmaker, or Mate, unless, as before stated, he may, in time of actual warfare, receive a higher promotion, as a reward for conspicuous services.

When entered as an apprentice, the boy's education, while partaking of a practical rather than a theoretical nature, is yet such as to enable him to rise to a higher position in either the Navy or the Merchant Marine than he would do had he not had the advantage of this training. The school turns out excellent gunners, top-men, quartermasters, helmsmen, coxswains, etc.

The law now allows that there may be at one time in the service, either serving aboard regularly commissioned vessels or under instruction at the training school, 1,500 apprentices ; and therefore new enlistments depend upon the number who have lately completed their term of apprenticeship, or who, having been found incompetent or undesirable, have recently been discharged.

Great care is taken in the selection of the candidates for admission. It is specially explained to those applying that this school is not to be regarded as a house of correction—that there is no desire to have any but good boys, both physically and morally. As soon as it becomes apparent that a boy has been entered because he is worthless and unruly at home, he is discharged, and even though parents may at first succeed in deceiving the questioners, the bad traits of the boy, when they later appear, are always grounds for his immediate dismissal.

This extra care is not so much to save time or trouble to the Government in attempting to educate a worthless and unprincipled boy, as it is to prevent the introduction of immoral principles among the other boys who have been by their parents placed here to be honestly raised to manhood.

Dishonesty, lying, and insubordination are the three principal causes which generally lead incompetent parents to endeavor to have the United States Government provide their son with that moral training which they have been themselves unable to bestow.

When a boy, even though entered as an apprentice, is found to possess these vices—vices which are generally the result of a want of early training—he is discharged from the naval service, that he may not serve as a bad example for better raised boys to follow. His discharge recites the reason thereof; and thus it will be readily seen that it is not advisable to place dissolute boys here in the hope of having them "made into something," a task that the parents have neglected, or else have found already to be impossible.

When it appears that a boy, though unruly, is yet one of good spirit—whose traits, while mischievous, are yet not vicious; whose disobedience is only the outcome of an exuberant boyish nature, he is corrected with the light punishments which the Navy Regulations allow, and is generally brought to be an honest and obedient man. There is a marked difference between disobedience of orders and insubordination. Disobedience is or may be the result of a spirit of fun—a desire to have a good time. It may result from forgetfulness or carelessness. Insubordination is that malicious resistance to authority which it is the first principle of naval training to stamp out.

It would be going too far to assert that those persons who are sometimes disobedient are better than those who are always obedient; but if it were possible to fill our navy with absolutely obedient seamen and officers, it is doubtful if there would exist enough freedom of thought aboard to take a vessel into action and fight her guns, or to do anything else, in fact, except study how to refrain from breaking the regulations.

In other words, the fact that the regulations are being constantly broken demonstrates that they may be so infringed without serious harm to discipline. It is not of so much importance that we keep the regulations at all times intact, as it is that those who transgress the law are made to understand that punishment is certain to follow the *slightest* as surely as the *greatest* infraction.

"What is the use of temptations, if we don't yield to them?" has been asked by a prominent writer, and in a like manner we may inquire, How can we enforce our Navy Regulations if they are not transgressed?

It is needless to say, therefore, that while the discipline aboard of the training ships and in the regularly commissioned vessels is always strictly maintained, yet allowance is made in the punishments, when inflicted, by taking into consideration the age of the offender.

The sailor early sees that there are some regulations that he must break or else he will have a very slow time. He decides for himself, and when he does infringe the law, he knows that he will be punished. He also knows that aboard of a properly conducted ship the punishment that he then receives clears off his account with the Government for that offense.

When first enlisted, the apprentice generally serves some months aboard one of the larger training vessels, and there acquires the rudiments of his profession—knotting, splicing, stations of the top, gun's-crew, etc., and later becomes one of a "draft" sent to one of the smaller vessels, the *Portsmouth* or *Jamestown*, whose sails and spars are easier managed by boyish hands.

During the pleasanter months of the year these vessels are constantly cruising. They visit the West Indies, the Azores, Madeira, and are sometimes allowed to proceed as far as the mainland of Europe. The apprentices are taught reading, writing, arithmetic, geography, and history, and are, generally speaking, given the groundwork for a good education. In case that any boy desires to pursue the higher study of navigation, he will always find some one aboard who will furnish him this assistance gratis.

When first enlisted, the apprentice is allowed to draw from the ship's stores clothing and supplies to the amount of $45. He receives, from the date of his enlistment, pay at the rate of $9 per month, and is allowed one ration, which amply supports him. After having been some time aboard, he is examined for promotion to a higher grade, and if he shows certain improvement, he is rated as Second-Class Apprentice, and then receives $10 per month.

Later he is again examined, and if passed to the higher grade becomes First-Class Apprentice, receiving $11 per month. The next successful examination makes him a Seaman Apprentice, Second Class, with pay at the rate of $19 per month, followed later by examination and promotion to Seaman Apprentice, First Class, with pay at rate of $24 per month. These are the rates of pay which he may receive while serving his apprenticeship.

Each succeeding year, whether at the training school or serving on one of the regular stations, the apprentice is assigned to a more responsible position, and thus, while his education is progressing, he is also of decided advantage to the naval service.

As soon as he has been proved to have certain aptitude in drill and studies, he is chosen as one of a draft to a regularly commissioned vessel, and is there placed to discharge still more important duties. His studies do not cease when he has been ordered into the regular service; each vessel which carries apprentices is required by law to have among her complement a person rated as schoolmaster, and whose duty it is to give daily instruction to those of the crew who have not finished their term of apprenticeship.

The apprentice is discharged on the day that he becomes 21 years of age. Should he be serving aboard a vessel on a foreign station he must be ordered to the United States in time to arrive and be discharged on that day.

He is then free to re-enlist or not, as he may choose. If he desires to remain in the Navy, he declares his intention of so doing; and then, if he signs the shipping articles at any time within the next 90 days, three months' pay is added to his accounts, and he receives one dollar per month in addition to the monthly pay of his rating, this being for what is known as "continuous service."

The constant drill, healthy fare, regular hours, and systematic training tend to develop the naval apprentice into a strong and hearty man; and though he may not choose to remain in the Navy, he is yet generally sure of a good place in the Merchant service or aboard of some yacht, etc.; and those so employed are always available in time of war, as a source from which to obtain seamen well drilled in the military part of their profession.

It is hardly to be expected that the majority of these will re-enlist in the Navy, so long as there exist outside more lucrative positions with easier hours of duty. But it cannot be considered that the benefits of the training school are lost, simply because an apprentice chooses to accept a better paying position elsewhere—a position generally secured by him wholly on the strength of his naval education.

During the year ending June 30, 1889, there were 2,738 applicants for enlistment as apprentice. Of these only 892—less than one-third—were found physically and morally qualified, and only 698—about one-fourth of the number of applicants—were finally admitted as apprentices. These figures show conclusively that the Navy Department does not intend to give this naval training haphazard, but only to persons who are able and willing to make good sailors of themselves, and be a credit rather than a disgrace to the service which has trained and educated them.

There are employed in connection with the training school and its cruising vessels about 60 officers, and perhaps 400 petty officers and seamen.

Notwithstanding the difference in their systems of education, yet in both schools there are certain principles of teaching which are common. Discipline is the same at each institution. The youth, be he under instruction for the position of commissioned officer or for that of seaman, is taught that, before he may expect to be placed in command of others, he must himself learn to obey.

Fine seamen can always be made out of those youngsters who live near the wharves of our sea-board cities—those boys who are always seeking the chance to sail a boat or row a skiff, and who are naturally born watermen.

Such a boy knows from the start that going to sea is

hard work, and not at all times the poetry that it has been so glowingly depicted by novelists. He knows that he may be sometimes ordered to "lay out" upon an ice-laden yard and furl a frozen sail; to "turn out" from his warm bed at midnight, to keep a sleepless watch in inclement weather—to go for days with nothing but salt food, etc.; and when these episodes in his seafaring life occur, he does not regard them as impositions, but as a matter of course.

It is preferable that, instead of leaving a comfortable home with loving and attentive parents, the boy be one who is seeking to make a home for himself; and such a home he finds aboard of one of our naval vessels.

When he comes ashore, you can generally distinguish the thorough sailor by his uncertain attitude as he walks the street, "taking bearings" alternately on the houses and the street car tracks. Quite different is the appearance of this same man when you find him on his native heath, the deck of a ship! With half an eye he sees the disarrangement of some insignificantly small rope-yarn, or a minute pleat in the furling of a sail. Not only does he see this, but his quick mind knows at once the remedy for the defect that he has discovered.

This is one of the earliest principles learned by the practical sailor—either officer or seaman—not to spend his time unearthing faults, unless he can show remedies for the same. The sea-lawyer, with his grumbling, growling and discontent, is rapidly becoming a thing of the past. The sailor of the present day finds faults—possibly as many now as formerly, but in a more reasonable way; and nine times out of ten can show that he has good theories as to how they should be remedied.

The best sailor is that man who lives for the sea—who regards the ocean as a part of his own particular birthright, and who thinks that, as the sea belongs to him, he therefore has not possibly as good a right ashore as the "land-shark," who so constantly fleeces him.

The moment he sets his foot aboard ship he feels a sense of relief, and commences to "put things to rights." It becomes second nature to the seafaring man to "put things to rights." This trait is born of the necessity of keeping everything in a small space.

It is noticeable that when a vessel of war is sent alongside the dock to be placed out of commission, the contents of the several holds and magazines form a pile twice or thrice the size of the vessel which contained them; yet this represents only her unexpended stores and ammunition. As we regard this pile we realize that nothing but the most exact stowage could replace it in the vessel.

So particularly is this exactness of stowage required that the business of stevedore, or stower, has become a profitable calling, and there are stevedores who can by the eye better estimate cubic space than a less experienced person would do with tape-line or yard-stick.

Every sailor becomes to a certain extent a stevedore; and it is not alone the man on the berth-deck who learns by experience to make the most of the "room and space" allowed him by the Government. The contents of a sailor's clothes-bag would astonish the landsman, who has all his life considered it necessary to have one or two trunks for his wearing apparel. A "Ditty-box," filled with articles of all description, ranging from ink and shoe-blacking to postage-stamps and skeins of the most delicately tinted silk floss, would, from the exactness and care with which each article is kept, excite the admiration of the most particular housewife.

Having thus to stow his worldly belongings in the smallest possible compass, the sailor early forms the habit of setting anything to rights that he may notice to be out of order. In fact, so noticeable is this trait that even landsmen themselves allude to "getting everything *shipshape*."

On one occasion, during quite a spirited quarrel which took place between two sailors, owing to too much alcoholic stimulation, the liveliest part of the row occurred when, being called upon to desist and "go to the mast," the combatants were not allowed the requisite time to replace two belaying pins which had been called into use during the *mêlée*.

(TO BE CONTINUED.)

ELECTRICITY FROM WIND POWER.

FROM the very moment that the storage battery became a practical, commercial apparatus its application to the storage of energy derived from the power of the wind was broached, but up to the present time very few attempts have been made to carry out the suggestion in practice. Our readers will therefore be interested in the plant operated by Mr. C. F. Brush, for several years at Cleveland, O. When we consider the widespread application of wind power to the operation of pumps for elevating water it seems indeed strange that no determined effort has been made to apply the same power to the storage of electrical energy. In the latitude in which we live steady winds may be counted on for the largest part of the year, so that the only remaining objection would be the cost of a windmill storage plant. We can readily conceive that a single pioneer plant, such as that of Mr. Brush, might involve considerably more expense than a second or third of the same nature, and, again, that the average plant would not require to be nearly as large. It therefore seems pertinent to suggest that this field so entirely unoccupied at the present time be seriously considered, as we are certain that a profitable if not a large business can be developed in this direction.

Electricity is already utilizing thousands of horse-power from watercourses, and is preparing for even more extensive work at Niagara, and there seems no good reason why it should not utilize the wind. We hear of plans now and then for getting something electrically out of the sunshine and the tides, but while that may be a remote result, it should be easy enough to transform the power of rising winds and falling waters.—*Electrical Engineer.*

THE TRANS-SAHARAN RAILROAD.

(From the *Bulletin* of the International Railroad Congress.)

THE question of the Trans-Saharan Railroad has been submitted by the French Government to a Commission, at the head of which is M. Alfred Picard, President of the Section of Public Works. Three lines have been submitted to this Commission; they are indicated on the accompanying sketch map. These lines are as follows:

1. The Western Line, explored by MM. Mauger and Fousset, which starts from the terminus of the Oran Railroad at Ain-Sefra, Algeria, and runs by way of Insalah to Timbuctoo, following as nearly as possible the line of the

oases. A branch to Bouroum, with a possible extension to Lake Tchad, is proposed. The distance is 1,240 miles to Timbuctoo; the branch to Bouroum is 435 miles.

2. The Central Line, advocated by General Philebert and M. Roland, which starts from the East Algerian Railroad at Biskra, runs through Onargla, Timassinin and Amguid and divides at Haggar, one branch running to Bouroum and the other to Lake Tchad. The length is 1,620 miles to Bouroum; the branch to Lake Tchad, 620 miles.

3. The Eastern Line, starting from Gabes, running through Ghadames and joining the Central Line at a point about 330 miles from the starting-point.

A line starting from Cape Nun has been proposed, and also one from the extreme west of Algeria, but these are not seriously advocated.

In connection with all the lines a road from the port of St. Louis on the west coast through Timbuctoo and Bouroum to Kouka on Lake Tchad is proposed.

The choice of the Commission will, of course, be influenced by political and military considerations. Thus for the western line the occupation of Insalah would require a serious campaign, while the adoption of the eastern line would involve difficulties with Tripoli. On the central line it would be necessary to establish small colonies at a few points, with military posts at Timassinin and Amguid; the latter is an important commercial point and a central post from which the Touareg tribes could be controlled. For these reasons the central line will be recommended.

It was originally proposed to build a narrow-gauge line on the Decauville system, but it now seems probable that a meter-gauge road with 45-lbs. rails will be recommended. The cost is estimated at a low figure, about $16,000 per mile, as no large bridges or expensive works will be needed.

ARMY ORDNANCE NOTES.

THE bids were opened January 5 at the Ordnance Office of the War Department for making 100 guns, which have been authorized by acts of Congress. Two bids only were received, each being considerably over the amount of the available appropriation, which is about $3,500,000. The first bid was from the Midvale Steel Works, of Philadelphia, and was in substance as follows: 8-in. guns, 25, for $22,028 each; 10-in. guns, 50, for $51,880 each; 12-in. guns, 25, for $88,592 each; the total bid amounting to $5,359,500. This Company offered to deliver one gun of each type within three years, and the remaining guns within eight years from the acceptance of the type guns. This would carry the last delivery over to 1901.

The second bid was from the South Boston Iron Company, of Boston, which has recently established new works in Kentucky. This Company offered to furnish the guns as follows: 8-in. guns, a type gun for $20,300 by January 1, 1893, and the remaining 24 at $20,995 each, to be delivered at the rate of six per year; 10-in. guns, a type gun for $46,560 by June, 1893, and the other 49 to be delivered at the rate of five per year and at the price of $48,000 each; 12-in. guns, the type to be ready January 1, 1894, and to cost $76,800, and the remaining 49 to be delivered at the rate of three per year after 1894, and to cost $79,200 each. In all cases 10 rounds of ammunition were included with each gun.

The South Boston Iron Company also submitted an alternate proposal to the effect that the firm would furnish the 100 guns for the amount stated by the Chief of Ordnance as the cost of the work at the Watervliet Arsenal, and in the same time as they could be furnished from there.

If General Benet's plan for completing the gun factory at Watervliet were carried out, the 100 guns could be produced by 1897, or within about six years from the present time. The cost would be somewhat greater, but the Government would have in hand one of the finest gun-making plants in the world, besides the guns. On the other hand, it would certainly be a great advantage to the Government to encourage the building up of private plants which would be able to furnish guns of the largest size when called upon in case of war or other emergency which may happen.

THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

BY M. A. MALLET.

(Paper read before the Société des Ingenieurs Civils, Paris; translated from the French by Frederick Hobart.)

AT the end of 1877, when I had the honor of treating the question of Compound Locomotives before your Society for the first time, there were only three locomotives of that kind in service and nine under construction, and these machines were all of small dimensions and upon roads of minor importance. At that time also the probable advantages of the compound system as applied to locomotives were not only generally contested, but many engineers were even unwilling to admit that the question presented any practical interest at all, their objections being based upon theoretical and practical considerations. To make the contrast more striking, I may say that at the Exposition, in 1878, in Paris, there was a single compound locomotive shown by myself, chiefly for the purpose of making a point or a date for the invention, and under the conviction that a much better showing would be made at the next Exposition.

Let us see if my conviction has been supported by facts.

At the last Exposition there were 15 compound locomotives; some exhibited in the galleries and others in service on the Exposition Railroad; and more than half of these belonged to the type devised by myself.

It will no doubt be a surprise to many to learn that there are now nearly 1,000 compound locomotives actually in service. In the report of Chief Engineer Parent on the Exposition, presented to the International Railroad Congress, tables were given estimating at 680 the number in service in June, 1889, more than 400 of these having been built within four years. This figure is below the real number. On two lines alone—the Northeastern in England and the Prussian State—over 150 compound engines have been put in service since this report was made. If we add the number in other countries, such as Russia and the smaller German States, we increase the number to over 900, divided between 70 or 80 roads, and there is no doubt that this is increasing very rapidly and will increase much faster, especially as the question has been taken up in the United States recently for the first time, and will doubtless be attended to with the energy and the decision which characterizes that country.

It may be said that I am exaggerating the importance of this question, since even this figure would not represent more than 1 per cent. of the total number of locomotives in the world. Nevertheless, even should the progress of the double-expansion engine be arrested instead of continuing to increase, this figure is much above the total which was attained by special systems which were considered very successful in their day, such as the Crampton, the Engerth and others.

Not only have distinguished engineers supported the compound system in the most efficacious manner, by adopting it, but many who were first opposed, better becoming informed or enlightened by experience, now advocate it and consider that it will take a more and more important position in railroad economy.

Railroad companies and the engineers in charge of their motive power may be, in fact, divided on this question into three classes: Those who have not tried the compound system; those who have it under trial, and those for whom the period of trial is passed.

The first class hardly needs further consideration.

The second class includes those lines where the system has been applied on a limited scale, in order that its advantages and disadvantages may be ascertained by actual experience. In this may be included all those lines which have less than 10 engines of this class, with the exception noted below.

The third class is that where the new type of locomotive may be considered as definitely adopted for a part or a whole of the motive power, whether this adoption has been based on actual experience on the road, or from results

obtained on other lines. We have included in this class those roads which have more than 10 compound engines, and also those which have less than 10, provided they are small lines on which that number would constitute a large proportion of the engines.

The first class is and will remain for some time the most numerous, but the second already exceeds 50, and the number is being every day increased, while the third now includes 25 companies, most of them of considerable importance. Among these may be numbered the Northeastern in England, which at a late date had 194 compound engines, 32 being in passenger and 162 in freight service; the London & Northwestern, which has about 100, nearly all passenger engines; the Prussian State Railroad, which on its Bromberg, Hanover, Frankfort & Magdeburg and Cologne Divisions has 205; a line in the Argentine Republic, which has nearly 50, and the Saxon State Railroad, over 40. The Vladicaucasus Railroad in Russia has ordered the change of all its locomotives, about 30 in number, to compound engines. This enumeration might be lengthened, but it is perhaps enough to say here that all the service of the Exposition Railroad in 1889 was performed by compound locomotives.

In the presence of these facts, it is impossible to deny that the compound locomotive is now a practical question in railroad operation, and that it can no longer be considered as merely an experiment. The objections which have been made to it by many engineers will be examined in detail later in this paper. It is enough to say here that there is no longer any doubt that its introduction marks the most important improvement in the locomotive of recent years; from my point of view the most important which has been made since the locomotive first assumed a practical form in 1829. Certainly, if it has done nothing else, it has caused discussion, investigation and experiment, which may lead to the attainment of the same end by other means.

It may be well here to give some account of the different types of compound locomotives so far built, and it seems best to continue the method of classification adopted in that original paper in 1877, and based upon the number of cylinders. I will commence with those of two cylinders, which were the first construction, and are at present much the most numerous. In the accompanying table I have collected the most important elements of 50 types of compound locomotives with two, three and four cylinders, which may be convenient for reference.

TWO-CYLINDER COMPOUND ENGINES.

In my first paper I said that the application of the compound system to the locomotive could be realized by the use of two cylinders working on cranks placed at right angles, and having between them a receiver of considerable capacity, and provided with a special apparatus permitting the engineer to make at will the working of each cylinder direct and independent of the other. This arrangement has met with many objections, but has succeeded in practice, and I believe that its use is limited only by the dimensions which can be given to the larger cylinder.

It may be interesting to note that the first mention of the use of two cylinders of different diameter for the locomotive dates back to the invention of the Wolff compound engines with an intermediate receiver. In fact, in a patent taken out in France, in February, 1834, by Köchlin & Company, of Mulhouse, an invention patented on account of the Dutch engineer Roentgen, who was the true inventor of the compound engine, we find the following phrase, which follows an account of the convenience of the use of the two cylinders on the Wolff system, acting on cranks placed at right angles, for steamboats—where such an arrangement would not require any more complication than the ordinary two-cylinder engine—"the same advantages will be found in the application of this system upon railroads." It is not less interesting to note that this phrase is not found in the English patent taken by Ernest Wolff, as representative of Roentgen, the text of which is otherwise almost identical with that of the French patent, and which is accompanied by the same drawing. Now it can hardly be said that the locomotive had less interest in 1834 in England than in France, and it is reasonable to suppose that the introduction of the sentence quoted in the French patent was due to Köchlin & Company, who, struck by the simplicity of Roentgen's statement, at once foresaw the ease with which it could be applied to locomotives, in the manufacture of which those eminent builders already anticipated great success.

Certainly there is no reason to exaggerate the importance of this simple mention made at the time when locomotives worked at a comparatively low pressure, but it is very interesting to know that this application of double expansion had been already indicated even before it had become common to use the expansive force of steam in a single cylinder, since at that time it was customary to admit steam for 90 or 95 per cent. of the stroke.

From 1834 we must go to 1850 to find an attempt to modify the ordinary method of working steam in locomotives. This is found in the system of *continuous expansion* patented in England by Samuel & Nicholson, which now forgotten, or considered only as a historical curiosity, has, since the success of the two-cylinder compound locomotive, been presented by many English authors as the first attempt at the application of the compound principle to the locomotive. It is to be regretted that some French writers have seemed to accept a claim which can only be based on a very slight knowledge, to say the least, of the principle of Nicholson's machine. It is enough to say that the continuous expansion system is not a derivation from the Wolff system, but, on the contrary, a deviation from it, as can easily be shown.

Two engines were arranged on this plan on the Eastern Counties Railroad, in England, one retaining the old cylinders, the other being supplied with one new cylinder of a capacity double that of the old one. The arrangement of the passages between the cylinders was such that live steam reached the first cylinder alone during about half of the stroke. At that point a direct communication was opened between the first cylinder and the second, the piston of which was at the dead point. The expansion was thus made simultaneously in the two cylinders up to the end of the stroke of the first one, which then commenced to exhaust directly into the air, while the expansion of the steam contained in the second cylinder continued until the end of its stroke. It is easy to say that with this system each cylinder had to submit to the almost complete fall in pressure and temperature, which the use of the compound principle, by dividing the expansion between the two cylinders, seeks to avoid as an essential object. The claim made by Mr. Samuel in the paper from which we quote was that *a part* of the steam discharged into the chimney to improve the draft in ordinary locomotives could be reserved for a further degree of expansion, and that the economy of the system of continuous expansion came from the part thus reserved for the purpose of utilizing its total capacity, which was lost in ordinary engines. He further stated that from one-half to two-thirds of the steam admitted was discharged from the first cylinder directly into the stack to secure the draft, the rest being carried to the second cylinder to be there further expanded and furnished additional work.

It will be seen at once that this is not at all the method of action of the compound locomotive, where *all* the steam which enters the first cylinder passes into the second, and where the draft is produced entirely by the steam escaping from the latter. In fact, the only reason which can be alleged for the continuous expansion arrangement is that the steam escaping from a single cylinder would not be sufficient to maintain the proper draft for the locomotive boiler. In figs. 1 and 2 we give a sketch showing the general disposition of the continuous expansion engine, as shown by the drawings annexed to Mr. Samuel's paper submitted to the Institution of Mechanical Engineers. We have done this in order to show the vital differences between it and the compound system, which is much the more simple. This is still further shown by fig. 3, in which the indicator diagrams of the two cylinders of the compound engine can be placed one above the other and combined in such a way as to show the manner in which the steam works successively in the whole apparatus. This cannot be done with the continuous expansion engine, where we

must limit ourselves to placing one diagram beside the other, since the expansion of the steam is there for the most

Fig. I.

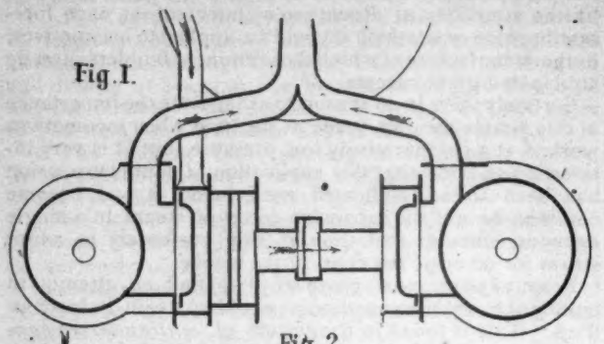
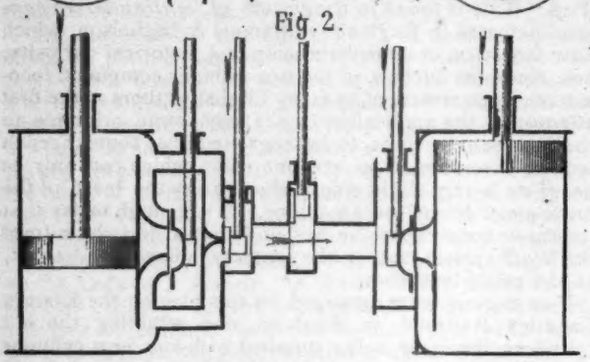


Fig. 2.



part simultaneous. This discussion might be continued much further, but sufficient has been said to dispose of the claim that it constituted the first invention or application of the compound principle. It is only necessary to add that Mr. Nicholson, in a public letter, protested against comparing his system to that of Wolff, alleging against the latter the drawback that the pressure upon the larger piston was really a counter-pressure upon the small one.

In 1874 we commenced to call attention to the ease with which the compound or double-expansion principle could be applied to locomotives without complication under the ordinary arrangement of two cylinders, and the first manager who was impressed with this principle was Monsieur Eugene Pereire, President of the Compagnie Générale Transatlantique, who was then occupied in building the Bayonne-Biarritz Railroad. An order for three compound locomotives for this road was given to the Creusot Works in 1875, and the first one was tried in 1876. Here was the real beginning of the compound locomotive.*

* It may be stated that the claim has recently been made that a compound engine was used on a steam passenger car on the Worcester & Shrewsbury Railroad, in Massachusetts, about 1860, but of this fact M. Mallet was probably not aware.

Since this engine—No. 1 on the table—contained all the essential arrangements, valves, receiver in the smoke-box, etc., and the 750 two-cylinder compounds now existing differ from it only in simple modifications of detail, it may be well to say that these engines were not in any manner ordered on account of experience, as some authorities have said. The Bayonne-Biarritz Company had no means of making any experiments, and these engines were ordered after mature reflection and a careful study of the principle, without hesitation and with a certainty of success which never wavered for an instant. The three engines which were so ordered have been in existence for 14 years, and for 13 of them in regular service on the line, where, aided by two other compound engines of greater power, built in 1878, they have run up to the present time a total of nearly 1,000,000 miles without showing any weak point either in principle or in construction.

The name of this little road is therefore an important one in the history of the compound engine, and will always figure in that of the progress of the locomotive.

The decisive success of these machines led rapidly to new applications of the principle, either by the building of new engines of small dimensions, or by the change of existing engines of larger size. The latter, however, at first had only moderate success, and it may be well to refer to this here, partly in order to correct some mistaken statements which have been made, and partly because some important conclusions may be drawn from this experience.

The management of a test of the comparative consumption of locomotives is always a delicate matter, which should be undertaken with many precautions. The general arrangement is to make the engines work for a certain time with ordinary locomotives, putting them as much as possible under similar conditions. The consumption of fuel and the loads are carefully ascertained, and at the conclusion of the trial the result is given, which very probably is that the new system is ingenious and well devised,

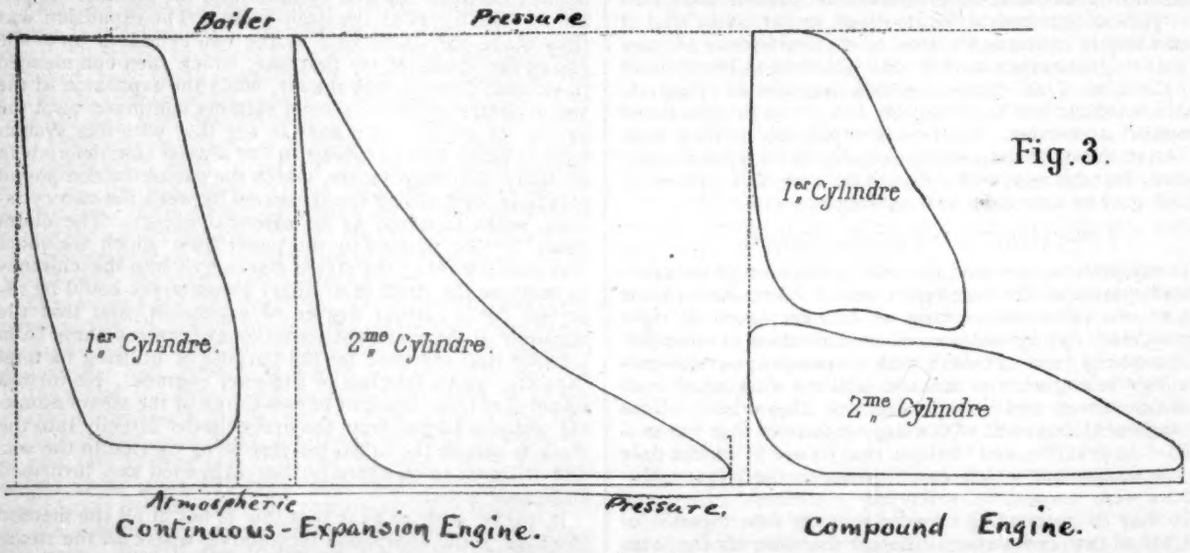


Fig. 3.

but has not given the advantages hoped for. In a word, the affair is judged and settled.

Often, however, the result really depends upon some little detail, which is entirely apart from the principle of the device tried. Many examples might be given, but perhaps one or two may be enough. In 1877 one of the engines from the Bayonne-Biarritz Line was tried on a branch of the Orleans system with an ordinary locomotive of about the same power, and on the first trial the results obtained were unfavorable, the compound engine consuming about 1 per cent. more fuel than the other. Upon examination it was found that the coal used was entirely different from that for which the grate of the compound had been made, and the consequence was that over one-third of the coal fell through the grate into the ash-pan without being consumed at all. A second trial being made, with proper changes, showed an economy of 31 per cent. in favor of the compound. At another trial on the Montereau Line the compound showed a saving of only 1.2 per cent., but

the engineer of the line, noting some points which he did not exactly understand, made a careful examination, and found that the compound engine did not have sufficient draft. On reducing the size of the exhaust nozzle and making some slight changes, a saving of 20 per cent. was realized.

These examples show once more the fact that in testing a machine it is absolutely necessary to eliminate as far as possible all disturbing circumstances outside of the single point under investigation.

The engine uses the steam which the boiler produces by the combustion of coal upon the grate. The motive power is thus obtained by a series of distinct operations, and to judge of any one of them by the final gross result is an elementary method which may lead to very erroneous conclusions. I do not seek to prove by this that all the trials which had not the most favorable results for compound engines were necessarily badly conducted, but simply to recall the fact that it is necessary to look twice before concluding for or against a new system, especially upon a few experiments. A hasty judgment is rarely final, and if it is flatly contradicted by later experience, such a result is not flattering to the first judges.

In 1878 a passenger engine on the Orleans Railroad was changed to a compound, by replacing the right-hand cylinder by a new one 21.65 in. in diameter, the other being 16.54 in. In this case the new cylinder was the largest that could be put in without making extensive changes in the engine, and was really too small in relation to the other. Moreover, this engine was, for the most part, run in connection with ordinary locomotives having cylinders 17.32 in. in diameter, and the alteration was so made that it was impossible to admit live steam from the boiler to the low-pressure cylinder directly. The boiler pressure also was not as high as it is customary to use in engines of later construction. Under all these circumstances, a favorable result was hardly to be expected, but this engine proved one important point, and that is, that the objections of additional repairs, loss of time, and mileage, etc., which have been urged against the compound, were without foundation. In a little less than three years, from October, 1878, to July, 1881, the engine had run about 60,000 miles. Results not altogether favorable were also obtained with an engine on the Kaiser-Ferdinand Northern Railroad in Austria, which was altered in somewhat the same manner. The objection made in this case was that too much force was exerted upon the large piston, which led to the racking and injury of the engine. It seems, however, that this might have been avoided by applying a reducing valve, or by a better arrangement of the throttle.

The apparent results of these trials were that the principal difficulty was the high degree of compression produced in the smaller cylinder at certain degrees of admission, but it does not seem that any effort was made in any way to prevent this compression. A change in the valve of the smaller cylinder would probably have been sufficient to improve very much the conditions of working, but in both cases the system was condemned without close examination, or without any attempt to improve it.

To these trials, however, only a very moderate degree of importance was attached because a test had been elsewhere under very different conditions, which had an important influence on the future of the compound locomotive. We refer here to a change made in 1879 by M. De Borodine on a passenger engine of the Southwestern Railroad in Russia. The change was made on plans furnished by myself, and the trials were conducted with great care and precision. This trial was followed by others, and led finally to the distinct adoption on the Russian State Railroads of the principle of double expansion, which is now required by the chief administration for all new engines.

In 1880 M. Von Borries, Superintendent of Motive Power of the Hanover State Railroads, encouraged by the success of the engines of the Bayonne-Biarritz Railroad, applied the compound principle to two four-wheel engines, which were used in local service, and which were built by Schichau at Elbing. His object was to do away entirely with the direct admission of steam to both cylinders, and to have the engine always worked as a compound in order to avoid some inconveniences, the importance of which he exaggerated very much. In these first machines the throttle valve was arranged in such a way as to send, when it first opened, live steam from the boiler to the intermediate reservoir, but to close this passage when it was further opened. These engines, in comparison with others previously used, which were exactly the same, with the exception of the compound arrangement, showed an economy of 20 per cent., which led the management to extend the application of the principle. The starting devise, however, did not give good results, and Mr. Von Borries changed it several times before reaching his present arrangement.

The next machines were two locomotives of about 38 tons weight with six-coupled wheels, followed in 1884 by several passenger engines.

In 1884 Mr. Worsdell applied the compound system in the same form to an express engine on the Northeastern Railroad, in England, which had cylinders 18 and 26 in. in diameter and 24 in. stroke, and driving-wheels 7 ft. in diameter. The starting arrangement was very similar to that of Mr. Von Borries, and an apparatus of this description, known as the Worsdell-Von Borries system, was applied to a large number of two-cylinder locomotives built for different lines in Europe, South America and British India.

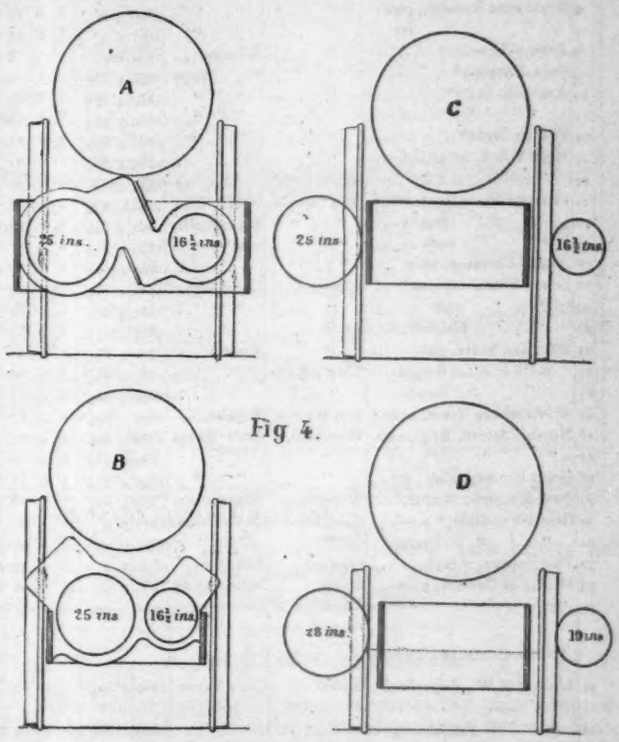


Fig 4.

While I admit the important services of Mr. Von Borries in introducing the compound engine, I hardly think that his friends have been justified in establishing a certain confusion between the automatic starting apparatus and the two-cylinder compound engine itself. This has been done by a number of English and German writers, but the fact is that if the two-cylinder compound engine is used, it is because it gives economical results with the least possible complication. Now these, especially the former, do not depend in any way on the use of a particular form of throttle valve. In fig. 4 there are reproduced four plans presented by myself before the Institution of Mechanical Engineers in London for compound engines, *A* and *B* being for inside-cylinder passenger engines; *C* for an outside cylinder passenger engine, and *D* for the outside cylinder freight engine. These arrangements are identical, even the proportions being almost the same as those which were used several years later in locomotives recently called the Worsdell-Von Borries. That name should really be applied only to the throttle valve arrangement.

M. Von Borries has also sought to present his engine as

TABLE OF DIMENSIONS OF FIFTY COMPOUND LOCOMOTIVES OF DIFFERENT TYPES.

No.	Railroad Line.	System.	Builders.	Date of Construction.	Gauge of Road.	No. of Wheels. Total.	No. of Wheels. Coupled.	Grate Surface.	Heating Surface.	Working Pressure.	Diameter of Small Cylinder.	Diameter of Large Cylinder.	Ratio of Volumes.	Stroke of Pistons.	Diameter of Drivers.	Weight. On Drivers.	Weight. Total.	Tractive Effort.	Proportional Volume of Expansion.	Volume of Expansion Reduced to Uniform Pressure.
	Two Cylinder Type.							sq.ft.	sq.ft.	lbs.	inches	inches		inches	inches	lbs.	lbs.	kilog.		
1	Bayonne-Biarritz	Mallet	Cr'us't W'ks	1876	4′ 8½″	6	4	10·76	485	142	9·45	15·75	1:2·78	17·72	47·25	31,960	39,672	1,080	4·14	4·14
2	" "	"	Passy W'ks.	1878	4′ 8½″	6	6	13·56	610	142	11·02	16·54	1:2·25	21·65	47·25	48,488	48,488	1,795	3·67	3·67
3	Haironville-Triancourt	"	" "	1877	1m't'r	6	6	6.99	351	142	8·66	13·58	1:2·53	15·75	29·52	31,960	31,960	1,290	4·38	4·38
4	Orleans*	"	Co.'s Shops.	1878	4′ 8½″	8	4	17·44	1,464	121	16·54	21·65	1:1·71	25·59	78·74	49,150	84,200	2,366	4·41	5·38
5	Spanish Northern*	"	" "	1878	5′ 6″	6	6	14·28	1,191	100	17·32	23·62	1:1·85	23·62	51·18	71,630	71,630	3,123	5·10	7·29
6	Southwest Russian, pass.	"	" "	1879	5′ 0″	6	4	15·70	1,126	128	16·54	23·62	1:2·04	23·62	66·93	58,400	79,350	2,802	4·79	5·32
7	" frt.	"	" "	1887	5′ 0″	8	8	23·68	1,346	128	19·69	27·95	1:2·01	25·59	51·18	103,600	103,600	5,625	5·36	5·95
8	Athens-Laurium	"	Kessler	1883	1m't'r	6	6	8·93	518	142	12·60	18·90	1:2·25	20·87	35·43	56.200	56,200	3,010	5·32	5·32
9	Jura-Simplon*	"	Co.'s Shops	1888	4′ 8½″	6	6	14·64	1,437	142	17·72	25·59	1:2·08	25·59	51·57	79 800	79,800	5,022	5·78	5·78
10	Austrian State*	"	" "	1889	4′ 8½″	8	8	21·11	2,017	142	18·60	26·18	1:2·00	24·88	46·65	102,500	102,500	5,898	5·07	5·07
11	" " *	"	" "	1689	4′ 8½″	6	6	18·90	1,292	142	16·58	23·62	1:2·03	24·88	49·76	77,140	77,140	4,430	5·14	5·14
12	French State*	"	" "	1888	4′ 8½″	6	6	12·92	1,084	128	16·54	23·62	1:2·04	23·62	59·45	73,850	73,850	3,151	4·27	4·74
13	High Speed, proposed	"	" "	1889	4′ 8½″	8	4	21·53	1,292	170	21·26	31·89	1:2·25	24·02	84·65	66,120	110,200	5,028	6·10	5·10
14	" " "	M'l't-Br'n'r	" "	1889	4′ 8½″	8	4	24·22	1,722	170	20·47	31·10	1:2·30	24·02	78·74	66,120	110,200	4,048	6·34	5·29
15	Prussian State, local service	Von Borries	Schichan	1881	4′ 8½″	4	2	8·61	371	170	10·60	16·54	1:2·40	16·54	44·49	24,500	44,000	1,627	6·19	5·16
16	" " freight	"	Henschell	1883	4′ 8½″	6	6	16·04	1,332	170	18·11	25·59	1:2·00	24·80	52·36	84,850	84,850	6,018	5·20	4·33
17	" " pass	"	"	1883	4′ 8½″	6	4	18·84	1,055	170	16·54	23·62	1:2·04	22·83	68·11	57,300	83,750	3,546	4·64	3·86
18	Alsace-Lorraine, pass	"	"	1889	4′ 8½″	6	4	16·47	944	170	14·57	21·65	1:2·22	19·69	59·05	57,300	76,900	2,735	3·87	3·22
19	Saxon State, express	Lindner	Chemnitz	1886	4′ 8½″	6	4	19·59	1,098	170	16·54	25·59	1:2·40	22·05	73·82	63,250	91,250	3,016	4·38	3·65
20	" " pass	"	"	1889	4′ 8½″	6	4	19·59	1,044	170	16·54	25·59	1:2·40	22·05	62·42	60.200	89,300	3,670	5·55	4·62
21	" " freight	"	"	1885	4′ 8½″	6	6	15·18	1,238	170	18·11	25·59	1:2·00	24·02	54·72	92,600	92,600	5,567	4·42	3·69
22	Bavarian State, pass.	"	Krauss	1890	4′ 8½″	6	4	20·34	1,191	170	16·93	24·02	1:2·00	24·02	73·23	63,900	93,650	3,639	4·21	3·51
23	" " freight	L'dn'r-Kr'ss	"	1889	4′ 8½″	6	6	17·87	1,355	170	19·14	27·76	1:2·10	24·80	52·36	90,350	90,350	6,717	5·74	4·78
24	" " local	"	"	1890	4′ 8½″	6	6	13·99	782	170	14·17	22·05	1:2·40	19·69	42·91	59,500	74,700	3,844	5·33	4·44
25	Wurtemburg State, pass.	Von Borries	Kessler	1889	4′ 8½″	6	4	17·11	1,132	170	16·54	23·62	1:2.04	22·05	64·96	61,712	90,400	3,408	4·36	3·63
26	North Eastern, Eng., exp.	Worsdell	Co.'s Shops	1888	4′ 8½″	8	4	17·33	1,195	160	18·00	26·00	1:2·12	24·00	84·00	71,630	....	3,330	3·88	3·47
27	" " "	"	" "	1889	4′ 8½″	8	2	19·91	1,140	176	20·00	28·00	1:1·96	24·00	91·34	39,670	104,470	4,214	7·38	5·95
28	Great Eastern, Eng., frt.	"	" "	1890	4′ 8½″	6	6	17·87	1,214	176	18·09	26·00	1:2·09	24·00	57·88	88,160	88,160	5,350	4·53	3·65
29	Jura-Simplon, Mogul	Winterthur	Winterthur	1889	4′ 8½″	8	6	16·15	1,305	156	17·72	25·20	1:2·01	25·40	59·84	79,350	96,600	4,767	4·86	4·42
30	Griasi-Tsaritsin,* pass.	Urquhart	Co.'s Shops.	1887	5′ 0″	6	4	....	....	128	17·25	25·28	1:2·15	24·00	65·00	52,900	....	3,334	6·54	7·07
31	" " *freight	"	" "	1888	5′ 0″	6	6	17·00	1,189	128	18·50	25·60	1:1·91	24·00	51·20	79,350	79,350	4,662	5·50	6·11
32	Vladicancus, freight	Lindner	Kolomna	1889	5′ 0″	8	8	19·91	1,916	156	19·69	27·95	1:2·01	25·40	47·24	109,100	109,100	7,439	5·51	5·01
33	Michigan Central, pass.	Pitkin	Schenect'dy	1889	4′ 9″	10	6	22·71	1,679	180	20·00	29·00	1:2·10	24·00	68·00	96,975	126,500	5,785	4·37	3·43
	Three Cylinder Type.																			
34	L'n'n & N.W., Experiment	Webb	Co.'s Shops.	1881	4′ 8½″	6	4	17·11	1,084	163	2 13·00	26·00	1:2·00	24·00	78·00	61,700	83,300	3,857	4·77	4·15
35	" " Dreadnought	"	" "	1886	4′ 8½″	6	4	19·91	1,362	180	2 14·00	30·00	1:2·29	24·00	75·00	66,120	97,000	5,070	6·19	4·95
36	Western, express	"	Sh'rp-St'w't	1883	4′ 8½″	6	4	16·90	1,060	150	2 13·00	26·00	1:2·00	24·00	79·13	57,300	81,550	3,453	5·06	4·82
37	French Northern	Sauvage	Co.'s Shops.	1888	4′ 8½″	8	6	22·61	1,224	200	17·00	27·56	1:2·68	27·56	64·00	89,500	104,500	5,552	5·22	3·73
	Four Cylinder Type.																			
38	French Northern, express.	De Glehn	Soc. Als'c'ne	1886	4′ 8½″	6	4	24·43	1,112	156	13·00	18·11	1:1·95	24·00	82·68	60,830	83,300	3,474	4·44	4·04
39	Decauville, articulated	Mallet	Decauville.	1887	2′ 0″	4	4	5·27	240	170	6·69	10·04	1:2·25	10·24	23·12	23,140	23,140	1,502	5·37	4·47
40	" "	"	"	1888	2′ 0″	4	4	5·27	240	170	7·36	11.02	1:2·25	10·24	23·62	23,800	23,800	1,817	6·29	5·24
41	Local lines, "	"	Soc. Als'c'ne	1888	1m't'r	4	4	8·18	452	170	9·84	14·96	1:2·31	18·11	35·43	49,600	49,600	3,832	6·56	5·47
42	Durango-Zamarraqua	"	Couillet	1889	1 "	4	4	8·39	452	170	11·02	15·75	1:2·04	15·75	35·43	50,700	50,700	4,177	6·17	5·14
43	Herault	"	Cail	1890	4′ 8½″	4	4	16·15	823	170	12·00	18·11	1:2·27	20·47	47·24	68,300	68.300	4,836	5·91	4·92
44	Central Swiss	"	Maffei	1890	4′ 8½″	4	4	19·38	1,346	170	13·00	21·65	1:2·40	25·19	55·12	112,400	112 400	6,912	5·40	4·50
45	Gothard	"	"	1889	4′ 8½″	6	6	23·68	1,658	170	15·75	22·83	1:2·10	25·19	48·43	169,800	169,800	9,990	4·54	3·80
46	French Northern	Du B'squet	Co.'s Shops.	1888	4′ 8½″	4	4	22·39	1,356	142	15·00	26·00	1:3·00	25·59	51·18	113 950	113,950	7,220	8·42	8·40
47	Paris-Lyons-Med. pass.	P.-L.-M.	" "	1889	4′ 8½″	8	4	25·19	1,340	213	12·20	19·69	1:2·61	24·40	78·74	65,250	117,900	4,469	5·23	3·48
48	" " " frt.	" " "	" "	1889	4′ 8½″	8	8	26·51	1,668	213	13·39	21·26	1:2·52	25·59	59·50	125,400	125,400	7,513	4·44	2·96
49	" " "h'vy gr'd's	" " "	" "	1889	4′ 8½″	8	8	23·47	1,647	213	14·17	21·26	1:2·25	25·59	49·61	125,700	125,700	10,030	5·28	3·52
50	Baltimore & Ohio, pass.	Baldwin	Baldwin	1889	4′ 8½″	8	4	25·08	1,604	163	12·00	20·00	1:2·77	24·00	66·00	75,400	105,350	3.883	5·49	4·78

NOTE.—Engines marked * were rebuilt from simple engines. The formula used for calculating "tractive effort" is $0{\cdot}50\phi \frac{d^2 l}{D}$.

The formula used for calculating proportional volume of expansion is $\frac{d^2 l}{DP}$. For computing proportional volume of expansion reduced to uniform pressure (142 lbs.) it is $\frac{d^2 l}{DP\phi}$.

a new compound system, claiming that his machine is always worked on the compound system, while mine could be worked either as compound engines or by steam taken directly from the boiler. Really there is no difference in principle ; it is simply a question of convenience ; because my locomotives can work as ordinary engines it does not follow that they must do so when it is not necessary. In fact, the direct admission of steam is only used under extraordinary circumstances. The economy again is not on account of the system of admission of steam, but the application of the compound principle. American engineers, disinterested as to the origin of the compound engine, have judged more fairly than those in Europe.

It has, however, been remarked with some malice that while the double-expansion locomotive with two cylinders originated in France, it is least employed there, and it would be difficult to give the reasons for this fact.

To go forward a little further, something has been done in many quarters with the compound locomotive either by construction of new engines or by the alterations of existing ones. In 1886 Mr. Thomas Urquhart, Chief Engineer of the Griazi-Tsaritsin Railroad in Russia, altered a six-wheel coupled freight engine to a two-cylinder compound to study the real value of the system. The results have been so favorable that Mr. Urquhart has already 21 of his engines changed to compound. All these engines, by the way, burn petroleum.

On the Holland State Railroads, some old engines were changed and some new compound locomotives were built at about the same time. On a few of these the singular arrangement was adopted of having two cylinders of unequal volume, but of the same diameter, the difference being made in the stroke. Thus both cylinders were 17.9 in. in diameter ; the stroke of one was 15.75 in., and of the other 31.50 in., which gave a ratio of 1:2 between the cubic contents. This arrangement was not continued, and the only reason given in its favor was the fear of having unequal strains upon two pistons of differing diameter, when steam was admitted directly, which was done by a throttle valve similar to those used on the Bayonne-Biarritz engines. Some very interesting experiments were made with these machines.

It is useless to go further in this enumeration. It is sufficient to say that of the 900 compound locomotives now in use from 700 to 750—that is, 80 per cent.—are of the two-cylinder type, of which we are speaking.

As I have said above, the engines of this type differ only from those built for the Bayonne-Biarritz by some small modifications in the arrangement of the minor parts. These are the starting apparatus and that for changing direction, and it will be well to review here briefly the more important of the forms adopted for these parts.

(TO BE CONTINUED.)

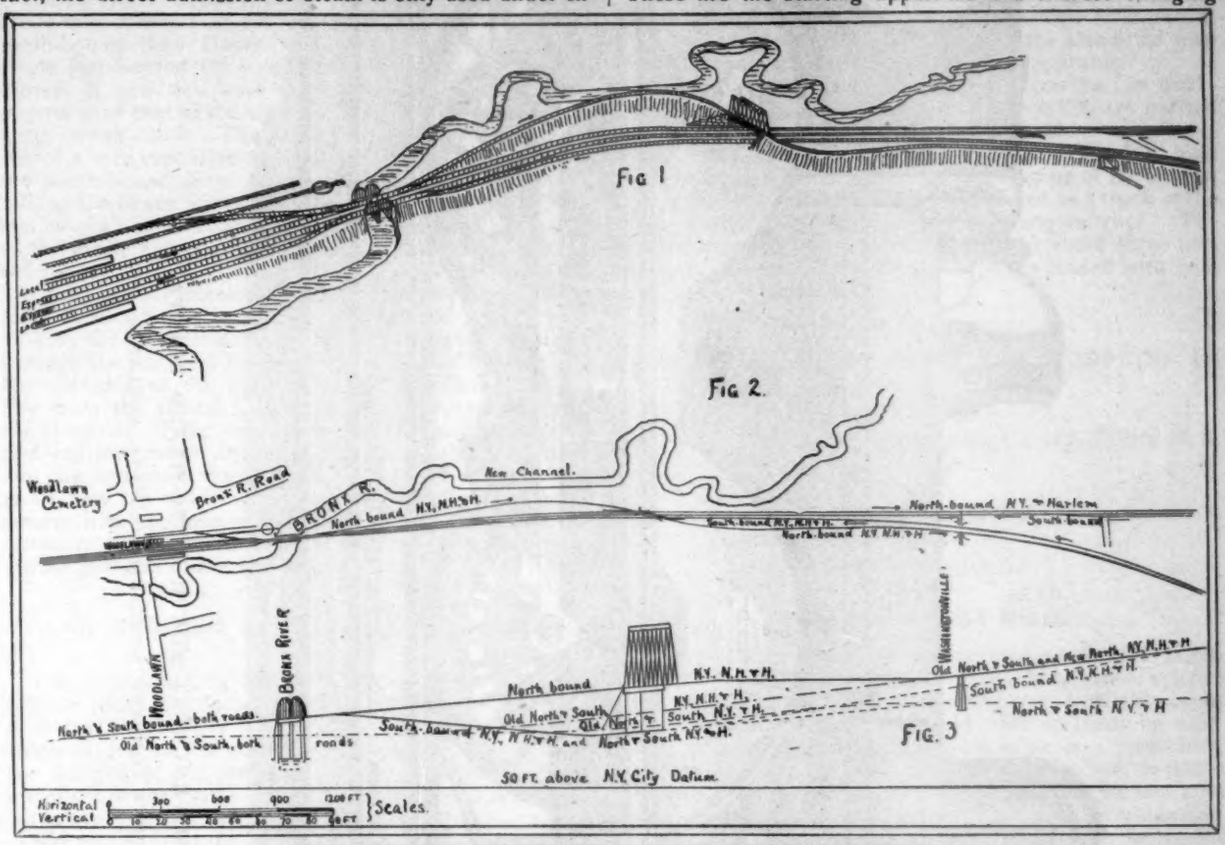


Fig 1
Fig 2.
Woodlawn Cemetery
Bronx R. Road
New Channel.
BRONX R.
North bound N.Y. N.H. & H.
North-bound N.Y. & Harlem
South bound
WOODLAWN
BRONX RIVER
North bound
Old North & South
N.Y. N.H. & H.
South N.Y. & H.
North & South bound, both roads.
Old North & South, both roads
South bound N.Y. N.H. & H. and North & South N.Y. & H.
Old North & South and New North N.Y. N.H. & H
South bound N.Y. N.H. & H.
North & South N.Y. & H
Fig. 3
50 Ft. above N.Y. City Datum.
Horizontal
Vertical
300 600 900 1200 FT
10 20 30 40 60 80 100 FT
Scales.

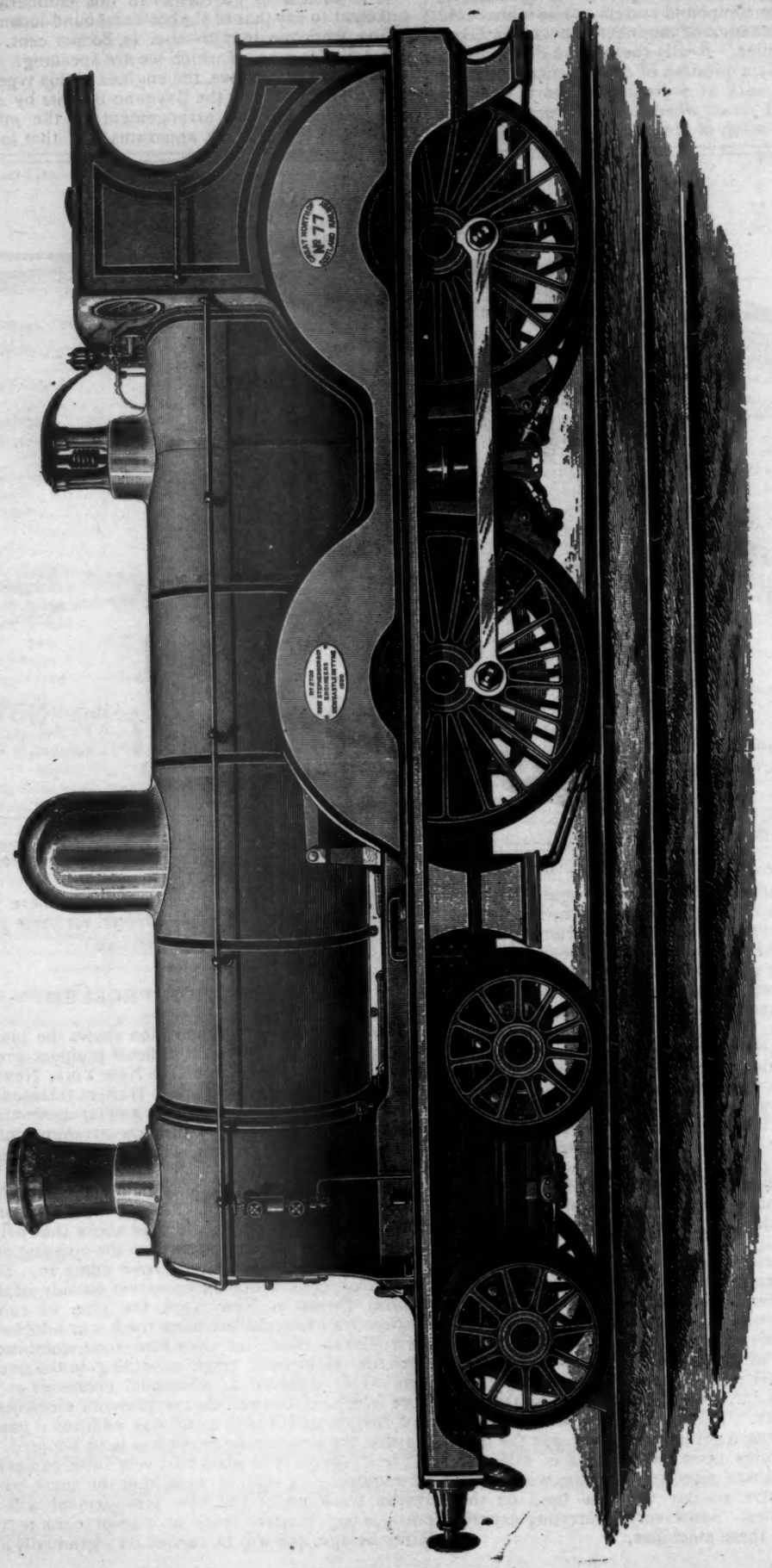
ARRANGEMENT OF TRACKS AT WOODLAWN JUNCTION.

A JUNCTION PROBLEM.

THE accompanying illustration shows the plan adopted in disposing of a somewhat difficult problem presented at Woodlawn, the junction of the New York, New Haven & Hartford with the New York & Harlem tracks, a few miles from New York City. Fig. 1 is a perspective view ; fig. 2 a plan ; fig. 3 a profile of the new arrangement of tracks and grades at this point, which has been designed by Chief Engineer Katté.

At Woodlawn station, just below the crossing of the Bronx River, the four-track line of the New York & Harlem Railroad terminates, the road above that point having a double track only, and just above the crossing of the river the tracks of the New Haven road come in. Some time ago, in order to avoid the crossover outside of the Grand Central Depot in New York, the plan of running the Harlem trains on the left-hand track was adopted, but the New Haven trains, on their own road, continued to run upon the right-hand track according to the general custom. This involved an additional crossover at the junction, which, of course, always presents elements of delay and danger, and it is to avoid this additional grade crossing that the new arrangement has been adopted.

The diagram is so plain that very little explanation will be required. It will be seen that the north-bound New Haven track under the new arrangement will leave the north-bound Harlem track at a point close to the Bronx River Bridge, and will be carried on a gradually ascending



EXPRESS PASSENGER LOCOMOTIVE, GREAT NORTH OF SCOTLAND RAILWAY.

BUILT BY ROBERT STEPHENSON & COMPANY, NEWCASTLE-ON-TYNE, ENGLAND.

grade for about 1,600 ft., when it will cross the Harlem tracks and the south-bound track of its own road on a bridge, and will continue on a level and then on a slightly ascending grade until it again meets the south-bound track. The grade of the Harlem tracks will be slightly raised from Woodlawn station to a point beyond the crossing of the Bronx, where it will change to a descending grade for about 1,500 ft., and then to a gradually rising grade until it meets the old level at Washingtonville. The south-bound New Haven track will leave the Harlem grade just beyond the point where the north-bound track crosses it, and will have a continuous ascent, slightly greater than that of the old line, until it is rejoined by the north-bound track. The work involved in this change is not of a very expensive nature. It includes the raising of the north-bound New Haven track on an embankment; raising the Bronx River Bridge; the bridge over the Harlem tracks; some embankment required for the change of the Harlem grades, and the excavation of a new channel for the Bronx River for a distance of about 1,000 ft. The gain in convenience and safety of running will much more than compensate for the additional expense.

With the completion of the work of sinking the tracks through the Annexed District of New York City, the Harlem Division of the New York Central has a four-track line from the Grand Central Depot to Woodlawn, with the exception of the short break at Harlem Bridge. The two outside tracks are used for running the local trains and the two inner tracks for express trains. In that distance also the road is now free from grade crossings of streets, being permanently below the city level. The only question which remains to be settled is the much-discussed problem of the Harlem River crossing.

AN ENGLISH EXPRESS LOCOMOTIVE.

THE accompanying illustration shows one of several express passenger locomotives recently built by the firm of Robert Stephenson & Company, Newcastle-upon-Tyne, England, for the Great North of Scotland Railway, from the designs of Mr. Robert Manson, Locomotive Superintendent of the road. For the engraving and description we are indebted to the London *Engineer*.

The engine is of the eight-wheel type, having two pairs of driving-wheels 6 ft. 6½ in. in diameter, and a four-wheeled truck in front, the truck wheels being 3 ft. 9½ in. in diameter. The engines have inside cylinders 18 in. in diameter and 26 in. stroke, the cylinders being cast together in one piece, the slide-valves being placed on the top of the cylinders, and driven by a link motion and rocking levers. The engines are fitted with balanced slide-valves, designed by Mr. Manson. The pressure on the back of the valve is relieved by a ring, which is held up to the casing door by a light tripod spring. This arrangement greatly reduces the wear and tear of the valves and gear, and since it was adopted by Mr. Manson on the Great North of Scotland Railway, engines have run 100,000 train miles, with a wear of the slide-valves amounting to only $\frac{3}{16}$ in.

The truck is provided with the ordinary swinging arrangement, which enables the engine to pass round curves with perfect steadiness. The main frames, which are of steel, are set in at the front end to give sufficient clearance for the truck wheels. The wheels are of wrought iron, and the coupled wheels have the balance weights forged solid.

The boiler barrel and fire-box casing are of best Yorkshire iron, the internal fire-box and tubes being of copper. There are 1087 sq. ft. of heating surface in the tubes, and 106 sq. ft. in the fire-box, giving a total heating surface of 1193 sq. ft. The grate surface is 18 sq. ft.; the fire-box is fitted with 16 copper air tubes, 3 in. external diameter, No. 7 w. g. thick, in two rows of eight in front and back, for conducting streams of air into the fire-box. This arrangement has been successfully used on the Great North of Scotland Railway for upward of 30 years, being originally employed as Mr. D. K. Clark's system of steam-induced air currents. In practice it has been found that the steam nozzles are not required when the engine is running, and the blower in the chimney answers when the steam is shut off. The boiler is fed by two No. 8 Gresham & Craven self-acting re-starting injectors, the water being delivered near the center of the barrel by a pipe inside the boiler, the clack-boxes being fixed on the back of the fire-box. Sand is delivered in front of the driving-wheels by Gresham's steam-sanding apparatus.

The engines are fitted with the Westinghouse brake, the main and auxiliary reservoirs for which form part of the drag-plate casting. The engines are also fitted with Mr. Manson's train tablet exchanging apparatus.

The weight of this engine light is 86,900 lbs.; in working order it is 94,100 lbs., of which 61,800 lbs. are carried on the drivers and 32,300 lbs. on the truck.

The tender is carried on eight wheels, the four hind wheels being connected to the main frame of the tender, while the four front wheels are connected to a truck of the same design and construction as the engine truck. The tank carries 3,000 gallons of water and about three tons of coal. The weight of the tender when loaded with coal and water is 80,600 lbs.

THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

BY FIRST LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

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(*Continued from page* 33.)

VI.—CONTROLLABLE MINES.

AN efficient system of controllable submarine mines was an impossibility until the progress in electrical science placed within the hands of the engineer a reliable agent through which this control could with certainty be exercised. A mechanical controllable mine is a possibility, as was shown in the early days of the Rebellion, to which reference has already been made; but to operate this kind of a mine requires such a concurrence of favorable conditions that, together with the unreliability of the agents which must be employed, it places it altogether out of the question in considering a system of mine defense. A controllable mine is, therefore, an electrical mine, although the converse of this is not always true, since some of the strictly self-acting mines are exploded by electrical agency, as has been previously described.

The same division into *Ground* and *Buoyant* Mines exists among controllable as in those that are automatic, although, from the conditions, a buoyant mine much better fulfills the requirements of a contact mine than one that is placed upon the bottom of a channel, and which must be exploded by means of a dummy or buoy attached.

Controllable Mines are classed under two different heads, dependent upon the method adopted for firing them, into *Observation* or *Judgment* and *Electro-Contact* Mines. An observation mine is usually a ground mine whose position is known by means of cross-bearings of objects on shore, by plane tables or other instruments, which will indicate just where the mine is and also when a vessel is above it.

This method of firing possesses the advantage of simplicity, since no circuit-closing arrangement is necessary—the battery, the fuse within the mine, and the key of the operator completing the electrical circuit. It was one of the first methods adopted for electrical mines. It is, however, open to the objections that a clear field of vision is required to locate both the mine itself and its object. Darkness, a thick fog, or the smoke of battle would render such a system for the time inoperative, except that a properly placed search light might obviate, in a measure, this difficulty. Furthermore, the greatest care must be exercised in putting down an observation mine so that its position cannot be mistaken; and finally the whole efficiency of the mine rests upon the man at the firing-key, who may err in judgment not only as to the relative posi-

tions of mine and ship, but also be at fault when called upon to decide upon the instant whether an approaching vessel be that of friend or foe—a contingency likely to happen in any harbor attack where fleets are engaged, and to face which would require a combination of coolness, nerve and quick judgment few men would care to be called upon to exercise.

An electro-contact mine, on the other hand, leaves nothing to the judgment of the observer as to the position

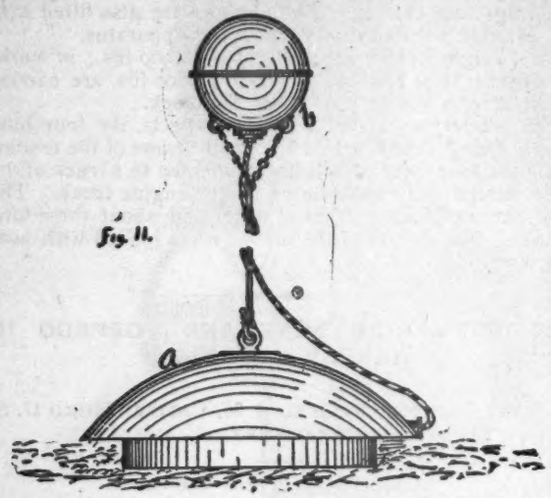


Fig. 11.

of an enemy's ship. He may mistake a friendly for a hostile craft, but he will never mistake its position, since the blow from a passing vessel will at once indicate to the shore station that it is above the mine. Such mines may be arranged so as to be fired at will or automatically. In the one case the blow closes an electrical circuit and signals the fact to the observer by dropping a shutter or ringing a bell, leaving it to his will whether or not to explode the mine; or the signaling current may, instead, be made to switch in a powerful firing battery, and thus explode the mine in a purely automatic manner. The advantages of such a system of mines in a channel or

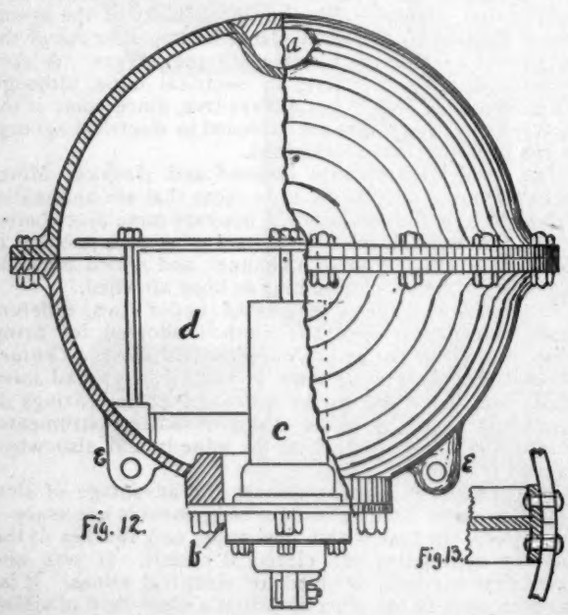


Fig. 12.

Fig. 13.

water way, that must be used by friendly ships and may be used by a hostile fleet, are too obvious to need mentioning.

An observation ground mine may be converted into a contact mine by the employment of a buoy anchored above it, which carries the circuit-closing apparatus, and with which it is in electrical connection. Fig. 11 shows such an arrangement, the buoy *b*, carrying the signaling or circuit-closing device, the mine *a*, containing the fuse and the explosive.

A controllable buoyant mine carries within its case a circuit-closer, an electrical fuse and the explosive charge. Fig. 12 shows, partly in section, the English spherical mine case—Gibbins'—previously referred to. It may be of iron or steel, in two hemispheres, and bolted together as shown. The upper hemisphere is provided with a sunken eye-bolt *a* for purposes of handling. The lower hemisphere has the loading-hole, *b*, into which is inserted and bolted a cylindrical case, *c*, containing the circuit-closer, the fuse and the priming charge. Secured within this lower hemisphere is an iron case, *d*, containing the main charge of explosive, in the center of which is the case containing the fuse and priming charge; *e e* are lugs for mooring purposes.

Another method of joining the two hemispheres so as to eliminate the objection to the protruding flanges of the other form—in the hold they would give to the grappling irons of an enemy—is shown in fig. 13. Here an inside web plate of T iron is provided, to which is riveted the edges of the two hemispheres.

Fig. 14 shows the form of the McEvoy ground mine. The case is of cast iron, the base of which is of sufficient thickness to give the necessary mooring weight. The dome-shaped portion varies from about ¼ to 1 in. in thickness, according to the depth of water in which it will be located. The case for the 500-lb. mine weighs 800, that for the 1,000-lb. mine, 2,000 lbs. In this figure *a* is the loading-hole; *b* the fuse and primer case; *c* the connecting cable, and *d d* lugs for handling or attaching a buoy.

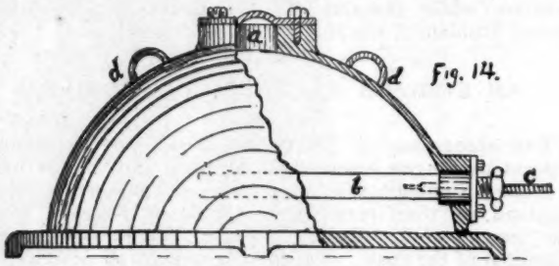


Fig. 14.

In the United States service the case for the buoyant mine is spherical in form and made of two thin hemispheres of steel, the narrow flanges of which are welded together, forming a water-tight joint. The hemispheres are pressed into shape by hydraulic machinery. The case for the 100-lbs. mine is 32 in. in diameter and ¼ of an inch in thickness. For ground mines the mushroom shape, as shown in fig. 11, is recommended. The material is cast iron; the size and thickness of case depending, of course, upon the amount of explosive it is to contain and the depth of water in which submerged; the buoy in this figure representing our spherical mine case.

All mine cases are tested for two qualities—that of being water-tight and having sufficient strength to resist external pressure. For the first, they are filled with water which is subjected to moderate pressure, and for the second are submerged in water of greater depth than where they are to be moored, and left for at least 48 hours.

VII.—CIRCUIT-CLOSERS.

In any system of electrical mines the most vulnerable part is the operating apparatus. It is that part most liable to get out of order and at the same time that upon which the whole efficiency of the system depends. No matter how powerful your mines may be nor how effectively placed if, when brought to the test of actual service, the smallest link in a rather intricate chain fails to perfectly perform its function, the failure of the whole system is sure to follow. The links in this chain, upon which so much depends, are the signaling and firing batteries, the connecting cables, the fuses and the circuit-closers. While all are equally important to the perfect working of the system, the circuit-closer is the more intricate in its construction, and more liable, consequently, to cause failure in the operation of a system of mines.

A circuit-closer, as used in submarine mining, is a contrivance for bridging a gap in an electrical circuit, which

circuit includes a battery of moderate power, the signaling devices, an electrical fuse imbedded within the firing charge, and some mechanism for switching in a more powerful current for firing purposes. Where the mine is to be fired at will the latter can be cut out or omitted altogether. The circuit-closer must be placed within some buoyant body and so anchored that actual collision with a passing vessel is certain. In the case of a simple observation mine no circuit-closer nor signalling device would be required. The only breaks in the electrical circuit, containing the battery and fuse, would then be the keys in the hands of the observers at the shore stations.

There are many kinds of circuit-closers, operating in different ways, and all of more or less intricate construction. All are, however, alike in the direction that the blow of a colliding body momentarily secures a metallic contact across the break in the circuit, which may be utilized either in firing the mine or simply signaling the presence of the vessel.

The simplest forms of a circuit-closer are those used in automatic electrical mines, previously referred to, where the colliding blow brings the electrical current at once into action to fire the mine without the intervention of an operator or of any superfluous mechanism.

The details of construction, or of the methods of connecting up the circuits, are held as professional secrets in many cases, notably so in our own service, although it is doubtful if there is any real secret in the matter among military experts in this line. Generally speaking, there is a vibrating body or weight, so held in place by springs or

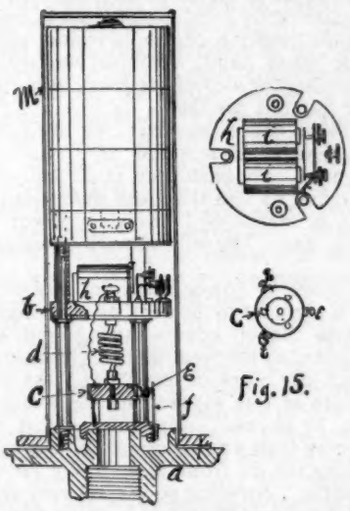


Fig. 15.

Fig. 16.

otherwise that only a violent shock can throw it out of position, and an electro-magnet, the core of which is usually wound with two kinds of wire, one fine of high, the other coarse, of low resistance. The testing and signaling current can be passed through the fine wire of the magnet and through the detonating fuse without danger. The suspended weight is so connected that when thrown out of position an electrical contact is made that shunts or short-circuits the current through the coarse wire, or outside the resistance coil, increasing its intensity sufficiently to operate the signaling apparatus or to fire the mine, either directly or by switching in a firing battery.

Fig. 15 shows the Gibbins' (English) circuit-closer, as given by Commander Sleeman. Into a malleable cast-iron base *a* are screwed two pillars which support a metal table *b*. From this table is suspended an insulated contact disk *c*, by a helical metallic spring *d*. Upon the circumference of this disk are three contact screws *e*, corresponding to which are as many contact springs *f*, sufficiently near that a blow will bring them together and close the circuit. Upon the upper side of this table is a relay *h*, consisting of an electro-magnet *i* and armature *k*. Above the relay and supported on the pillars is a case *l*, containing the detonating fuse and the priming charge, held in place by a spiral spring at the top. The whole is enclosed in a drawn steel envelope *m*, closed at the top, provided with a flange and screw collar. The core of the magnet is wound with fine wire of about 2,000 ohms resistance, and with a coarse wire with a resistance of 4 ohms.

When in position a weak signaling current is constantly passing through the fuse, an electro-magnetic signaling shutter on shore, through the fine wire coil of the relay and to earth. This current is strong enough to test the fuse and to transmit signals, but too weak to drop the shutter or to fire the mine. A violent blow, as from a passing ship, starts the suspended contact disk *c* into vibration, touching the contact springs *f*. This contact shunts the current through the circuit of low resistance, which is then strong enough to drop the signaling shutter on shore. The observer can then fire the mine by throwing a firing battery into circuit, or it can be made automatic by an arrangement that will throw this battery into circuit when the mine is struck.

In the Chatham circuit-closer, which is the one recently adopted in the English torpedo service, there is a brass ball suspended by a spiral spring from the apex of a tripod frame. Below this ball are two relays, one wound with wire of 2,000 ohms, the other with wire of only 5 ohms resistance. Ordinarily the current passes through the high resistance relay, but when the ball is made to oscillate contact is made through the low resistance coil, giving the current sufficient additional power to operate the signaling or firing apparatus.

In the United States the details of the submarine mine service are carefully guarded. The wisdom of attempting to maintain such profound secrecy in this or any other branch of national defense may at least be questioned. In the first place, such a policy can be carried out but imperfectly, and besides the benefit of intelligent criticism is lost. One well remembers the price the French nation paid for the extraordinary precautions taken in the years just preceding the Franco-German war to maintain the secret of the famous *mitrailleuse*. An arm that might have played an important part in the struggle, and possibly have changed the result on more than one occasion had it been intelligently handled, was sent into the field with neither the capabilities of the arm nor the mechanism of the gun itself thoroughly understood by anybody. Major Clarke, of the Royal Engineers, recently writing upon the subject of mine defense, says: "Each nation pretends keen anxiety as to the secrecy of its apparatus, and each knows all about its neighbor's paraphernalia. The fiction of mystery must be maintained, however, for is it not calculated to enhance the moral effect which is assumed to attach to *omne ignotum?*" The same writer also says: "It may well be that submarine mines will eventually suffer from the want of a little daylight, or even a little criticism from the outside."

Without going into forbidden details, it may be said that the electro-contact mine is the one most relied upon in our service. In putting down a system of mines two batteries are provided—a signal battery with a potential of 7 or 8 volts, and a firing battery of something like 150 volts. A metallic cylinder containing a fulminate of mercury fuse and a resistance coil is screwed into the base of the torpedo case and made water-tight. A current from the signal battery passing through the fuse and the resistance coil is supposed to be on at all times. A blow upon the torpedo case serves to short-circuit the current outside the resistance coil, giving it sufficient additional strength to actuate an electro-magnetic signaling device at the shore station, or automatically bring in the firing battery, much in the same way as has been described in the English service.

VIII.—ELECTRICAL MINE FUSES.

An electrical fuse is a device for producing an explosion by means of electrical agency, and consists of a small charge of an explosive properly placed in the circuit of an electrical current. There are two general classes—high and low tension—according to the character of the current employed. The former employs a small current of high potential, the latter a larger current of lower potential. In the high tension fuse, advantage is taken of the capability of a current of this kind for throwing a spark across an appreciable break in its conductor, by placing in this gap a compound sufficiently sensitive to be

ignited by this spark. In the low tension fuse, instead of a break, there is introduced a bridge of fine platinum wire, which is brought to an incandescent heat by the resistance it offers to the passage of the current.

A high-tension current possesses the advantage of being so little affected by line resistance that small wires may be used, but perfect insulation is very necessary. It can also be employed to fire mines at a great distance. With a low-tension current the line resistance is considerable and wires of larger section must be used, and where the distance is great only a small number of shots can be fired simultaneously. On the other hand, the advantages of using a low-tension current for mine work are so great that it is now almost universally used for that purpose. The opportunity it offers for constant and careful tests of the condition of the fuses and of the whole electrical apparatus, together with the fact that with it there is little danger of producing induced currents in contiguous wires—a grave objection to high-tension currents—sufficiently explain the reason for the adoption of the low-tension fuse.

The English and American service fuses do not differ materially. In both cases the bridge is of iridio-platinum wire. Fig. 16 shows the American fuse, which can be understood with little explanation. In it *a* is a wooden cylinder, grooved longitudinally on opposite sides to receive the conducting wires; *b* a cap closely fitting over *a*, closed at the upper end by a paper disk. The ends of the two wires *c c* are bared and connected at their extremities by a bridge of iridio-platinum wire *x* about $\frac{1}{4}$ in. in length and .0025 in. in diameter, and surrounded by a priming *d* of fulminate of mercury. Over this is placed a cylinder of thin copper *e* containing the detonating composition *f*, held in place by a paper disk. The dimensions of the finished fuse are 1.4 × .4".

In the English fuse the two bared wires are fixed in a beech-wood head, above which is a tin tube containing the priming and detonating charges. Dry gun-cotton is placed around the bridge. The English use the term *fuse* where gunpowder is used for the priming charge, and *detonator* where it is of some of the detonating compounds—usually fulminate of mercury.

(TO BE CONTINUED.)

RAILROAD NOTES FROM BRAZIL.

OUR Brazilian correspondent, writing from Ceara, says that two railroad extensions are now being discussed in that place. Fortaleza, commonly called Ceara and capital of the State of that name, is a seaport in about 3° 40′ south latitude. For some years past there has been in operation a line of meter gauge running from Fortaleza to Baturité, about 60 miles nearly due south. An extension has just been completed about 30 miles in length, and construction is now in progress as far as Quixada, 60 miles from Baturité. The Government has announced its intention of prosecuting the studies—that is, preliminary surveys—thence to Crato in the extreme southern end of the State, about 375 miles from Ceara.

Crato is nearly due west of Recifé (Pernambuco), and a guarantee has been obtained of 6 per cent. yearly for 20 years on an extension from Cariaru, the present terminus of a road from Recifé, to Crato, the expenditure not to exceed 30 contos per kilometer or about $24,000 per mile.

The Baturité line is worked by the Government, and there is considerable complaint as to the management. Freight suffers great delays. A somewhat amusing incident occurred on the opening of the new line, to celebrate which a special train ran to the end of the track, but the two engines having given out the guests had to pass the night in a station house where there was no drinking water, which was very unfortunate, as most of them suffered from thirst, which some malicious commentators attributed to the abundant potations of champagne on the trip out. The road is fairly well constructed, but there are some errors in location, and a straight tangent is rare, although the country is not heavily timbered.

On my first trip over the new line I rode from Baturité up into the hills, reaching a height of 2,600 ft. amid very fine scenery. It is on the steep hill-sides and in the little bottoms of the mountain country that the wealth of the State of Ceara—the coffee, sugarcane, cotton and fruit—are to be found, as the lowlands are parched, and comparatively unused and unsettled. An American company has been boring for water here for about two years, but so far, I believe, with but little success.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

XIV.—THE COVERING POWER OF PIGMENTS.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(Copyright, 1889, by C. B. Dudley and F. N. Pease.)

(*Continued from page* 548, *Volume LXIV.*)

IN approaching the question of covering power, it is fair to say that the subject is a very difficult one, and that although we have made a very large number of experiments, and have spent a good deal of time in trying to exhaust various points as they have come up in our studies, we are not at all sure that we have obtained final satisfactory information on some of the variables, nor that we shall be able to give a perfectly lucid explanation of everything connected with the question of the covering power of pigments. On the other hand, we think we will be able to give a fairly intelligent idea of the most important variables which enter into this problem.

Before taking up these points, however, we think it is essential to define what is understood by "covering power," since the words have been used in a number of different senses. We find no less than four definitions or explanations of what is meant by "covering power" in more or less common use. We will remark on each of these in turn.

First, the words "covering power" may be used to express the power of a pigment to protect oil. In paints which dry with a gloss the oil covers the pigment, and practically what is exposed to the weather is a glossy layer of oil. In paints which dry more or less "flat," the pigment is practically more or less exposed to the weather, being held in position by an extremely thin layer of oil, and in reality, if we may trust our experiments, is a valuable means of protecting the oil from decay. We do not think this use of the words "covering power" is very common, but for the sake of completeness we give this explanation—namely, that covering power may mean the protection or covering of the oil by the pigment. It is obvious that this protection is obtained by the proportions of oil and pigment. A large amount of oil and a small amount of pigment would produce a paint in which the oil would protect or cover the pigment. On the other hand, a large amount of pigment and a small amount of oil would produce a paint in which the pigment would pro-

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

tect or cover the oil. We shall refer to this question of the mutual protection or covering power of pigment and oil later on, and will only say here that, according to our studies, that paint is much the best for durability in which the pigment is used in such proportion as to protect or cover the oil.

Second, the words "covering power" are sometimes used to express the amount of color on a surface; or, in other words, if a surface has plenty of color on it—in the case of color pigments, for example—the covering power is said to be good. If the surface is deficient in color we say the covering power is poor. This definition or meaning of covering power may perhaps best be made clear by citing examples of paints, which would be regarded as having good or poor covering power in this sense. Thus, if we may trust our experiments, if an iron oxide paint is proportioned so that the liquid and the pigment bear to each other the ratio of about 50.00 per cent., pigment and 50.00 per cent. liquid by weight, when the paint is ready for spreading, and if the amount of iron oxide in the pigment is perhaps 30.00 to 40.00 per cent. the paint will have good covering power, so far as the amount of color on the surface is concerned. If, on the other hand, a paint is so proportioned that the amount of pigment and the amount of liquid are in the ratio of 10 parts pigment to 90 parts of liquid, or if in an iron paint properly proportioned otherwise—namely, 50 parts pigment and 50 parts liquid, the amount of iron oxide in the pigment is not over 3.00 or 5.00 per cent., both of these paints would be deficient in covering power in the sense in which the words are used in this paragraph. It is plain to be seen why this should be so—namely, there is not enough pigment of the desired color to properly cover the surface. Although in the last case mentioned above there is enough pigment for the proper protection of the surface, yet the pigment is deficient in coloring material, and consequently in the proper covering power. The deficiency in covering power, in the sense in which the words are used in this paragraph, most commonly occurs in actual practice from the use of too large an amount of diluting material in the paint. We have seen paints in commercial use which had such large amounts of volatile diluting liquids, that when they were put on surfaces, and the volatile material had evaporated, the coats were so thin that fairly they could be said to be deficient in covering power, in not having enough pigment to fairly cover the surfaces. Such paints approximate to what may be called "stains." It is more rare, we think, in actual service that the pigment contains a deficiency of the desired coloring material, although this will, if we are right, give the same undesirable result in the finished paint.

Third. Another sense in which the words "covering power" are very commonly used is to express the amount of surface that a given weight of paint will cover. Thus it is claimed that a good iron paint, pound for pound, will cover nearly twice as much surface as white lead or red lead, and it is well known that Prussian blue is, to use the language of the trade, one of the "strongest" paints in service, having what fairly may be called enormous covering power in the sense in which the words are used in this paragraph. The various pigments differ very widely in their covering power in this sense, provided comparison is made by weight, and it is not at all difficult to see why this should be so. All other things being equal, it is obvious that the same covering power will be obtained whatever the pigment, provided the same number of particles of the same size, and of the same power of impeding the passage of light, which will be treated under the next heading, are on the same number of square inches of surface. In other words, if a square inch of surface has 100,000 particles of the same size of white lead, or of oxide of iron, or of Prussian blue, or of yellow ochre, or of any other pigment, and if each of these pigments has the same power of preventing or retarding the passage of light, it is obvious that the surface will be equally well covered by the use of each. But it is well known that each individual particle of each pigment has its own peculiar weight. This is in reality its specific gravity. Thus, for example, a single particle of white lead is about 6.4 times as heavy as the same volume of water, while the same sized particle of iron oxide is only about 5 times as heavy as the same volume of water, and yellow ochre is from 3½ to 4 times the weight of the same bulk of water and so on. It is obvious, therefore, since pigments differ so much in the weight of their particles of the same size, that it would be impossible to get the same number of particles of the same size on a square inch of surface out of the same weight of material. In this third sense, therefore, the covering power of paints bears close relation to their specific gravity, the lighter paints having the power of covering the greater amount of surface. Of course it must be carefully noted here that the fourth and most important sense in which covering power is used may very greatly modify this statement. If all pigments had equal covering power in the fourth sense, it is unquestioned that those of the lightest specific gravity would cover the largest amount of surface pound for pound. Unfortunately many of the light pigments do not have good covering power in the fourth sense, and so, as said above, it is hardly possible to make the universal statement that those pigments which have the lightest specific gravity will cover the largest amount of surface for the same weight of pigment.

Fourth. The fourth sense in which the words "covering power" are used is an optical one, and has to do with the behavior of pigments toward light. This is really the most important sense in which the words are used, and when any new pigment is brought forward it is the most important sense in which its properties are studied. If its optical covering power is defective or inferior, although the pigment is satisfactory in every other sense, it will never be regarded as a good pigment, and all mixtures of pigments and all new shades are in practice first subjected to the test of optical covering power before they can be regarded as satisfactory. Indeed, we query whether Master Painters do not regard the optical covering power as the principal sense in which the words are used. In our observation and experience it is certainly the first question that is asked, and the first test that is made by Master Painters when any new paint is offered. It is also in this sense—namely, optical covering power—that we have put most of our study on pigments for the last few months, and we find the problem, as stated at the outset, very much more complicated and very much less easy of solution than we had supposed. The optical covering power of pigments may perhaps best be defined as their power when spread on a transparent surface, as, for instance, a piece of glass, of preventing the transmission of light through the glass, and this is one of the common methods of studying the optical covering power of pigments. Another method is to spread some of the pigment, properly mixed as a paint, of course, over a dark surface or a light surface, and see how completely it prevents the light from going through the pigment to the dark or light surface underneath, and then come back to the eye. If the pigment has good covering power a single coat many times will cover a light or dark surface so completely that it will not be visible through the layer of paint. If it has poor covering power, not only will one coat not cover the light or dark surface underneath, but in some cases even many coats will not prevent the light passing down through to the light or dark surface underneath and coming back to the eye. In other words, the pigments of poor covering power will not hide a surface underneath a pigment, while a pigment of good covering power will, or what amounts to the same thing practically, a pigment of poor optical covering power spread on a glass will not prevent the light from passing through, or prevent the observer from seeing some object through the paint and glass, while a pigment of good optical covering power will prevent both.

Much study has apparently been put on this subject, as we find considrable on record in the books, but we are not aware of any place where the problem has been stated and all the information brought together so as to give a tangible and lucid explanation of the matter. We will do the best we can toward making this complicated subject clear.

We began our studies by assuming the following hypothesis—namely, if any two contiguous square inches of

transparent surface, as, for example, a piece of glass, are covered with the same number of particles of the same size, the light will be equally prevented from passing through the two, irrespective of the nature of the particles—that is to say, if one square inch of the piece of glass had 10,000 particles of white lead spread over it, and another square inch had the same number of particles of the same size of barytes, sulphate of lime, silica, whiting, or ground glass if you choose, spread over it, the two surfaces would be equally well covered. This is unquestionably true so far as mechanical covering is concerned, but to our chagrin, after spending a good deal of time in trying to reduce several pigments to the same sized particles, we found that this hypothesis did not hold true, and that covering power was based on a still deeper relation than the breaking up of the light by the finely divided particles. The proposition as stated does fairly well hold true with dry pigments—that is to say, if dry pigments are put on a piece of glass, the layer in each case having the same thickness, and the pigments of approximately the same degree of fineness, the power to break up the light and prevent it passing through the glass to the eye is approximately the same, whatever the pigment, at least so far as our experiments have gone, and we have tried white lead, zinc white, talc, sulphate of lime, barytes, feldspar, silica, and powdered glass. We conducted our experiments with these dry pigments in two different ways. First, we took a very fine silk gauze, which approximately measured 0.004 inch in thickness, and stuck this to a piece of glass with some gum water. This gave us a mesh on a piece of glass, which mesh was rubbed full of the different kinds of pigments which we experimented with. We had no absolute means of determining the size of the particles in every case, but even ignoring this, we found that a piece of glass so arranged and held between the observer and the light would shut off any object on the opposite side, or prevent the light passing through almost equally well, irrespective of the nature of the pigment. We did not find this to hold absolutely true, but very largely so—that is to say, the powdered glass sufficiently fine would shut off the light under these conditions almost equally as well as white lead. Another method of experimenting consisted in mixing up the various pigments with a very dilute solution of gum water and spreading them with a brush on glass. The water evaporated and the amount of gum left was extremely small, but still sufficient to hold the pigments on the surface. In this case, again, the covering power of the various pigments differed some, but not very greatly, and it was astonishing how completely powdered glass would shut off the light. Unfortunately, however, when we came to use oil as the medium to hold the pigments on the surface, which is the state of affairs in ordinary painting, as is well known, our theory broke down completely. With white lead a single good coat on glass would give a very fair cutting off of the light. With sulphate of lime, talc, whiting, or powdered glass, although we were careful in every case to have the same volume of pigment on the same amount of surface, the cutting off of the light was in many cases very slight, and in some cases indeed there was very little interference with the distinguishing of objects on the opposite side of the glass. We are quite well aware that this is common experience, and that these tests are made frequently by Master Painters and others, always, we believe, with the same result—namely, that certain pigments do not have covering power in the sense of preventing light from passing through a transparent surface coated with them when the pigments are mixed with oil.

Our experiments given above, however, point very clearly in this direction—namely, if we can get good covering power, and very little difference beween pigments when pigments are put on the surface dry, or approximately dry, which good covering power disappears when the pigments are mixed with oil, it must be some relation between the oil and the pigment which destroys the covering power in the case of the inferior pigments. On looking up the literature of the case we find that considerable experimentation has already taken place on this subject, and that the necessary experimental data have been obtained to explain the facts given above. Professor Von Bezold, in his "Theory of Color," published by the L. Prang Company, gives the following:

> If we fill the lower part of a small glass tube—a test tube, for example—with coarsely powdered glass, the powder will appear white, and it will be impossible to see through it; but as soon as we pour water into the tube, the powder will become translucent to a certain degree. By substituting turpentine for the water, the degree of translucency is considerably increased. Furthermore, if we add a small quantity of sulphuret of carbon to the turpentine, we shall obtain a liquid which refracts [bends] the light about as powerfully as glass, and if we now pour some of this liquid upon the powder, the latter will disappear almost entirely to the eye, and we shall be able to look through the glass freely, as if it contained only the clear fluid, without the least particle of powder. If we immerse a glass rod in such a liquid, instead of which we may also employ a mixture of olive oil and oil of cassia, it will appear as if the rod reached only to the surface of the liquid. Within the liquid the presence of the rod cannot be detected; it is perfectly transparent.
>
> It is shown by these experiments that the presence of one transparent body within another is only betrayed to the eye, when the two differ in their power of refracting light. If this is not the case, the light passes through the mixture without obstruction.

These experiments of Professor Von Bezold seem to us clearly to indicate why we run into difficulty, so far as covering power goes, when we attempt to use many of the common substances as pigments—namely, the reason why they do not cover the surface is because they refract the light so nearly like the oil. We find that the index of refraction of linseed-oil, as given in the books, is 1.48, while the index of refraction of ordinary glass is about 1.50 to 1.55, of white lead is 2.00, of silica is 1.55, of whiting is 1.65, and of feldspar is 1.54, while chrome yellow is 3.00, and vermilion is 3.20. If this theory and these experiments therefore can be trusted, it is absolutely essential that the index of refraction of the liquid or medium which surrounds the particles of pigment should be different from that of the pigment itself in order that the pigment may have good optical covering power.

There is quite a large amount of confirmatory data upon this point. With powdered glass, for example, the lower the index of refraction of the medium which surrounds it the better the covering power of the glass appears. Thus if we use water, the index of refraction of which is 1.34 instead of 1.48, as is the case with linseed-oil, the covering power is better than with linseed-oil. If we use air surrounding the particles of pigment, the index of refraction of which is very nearly 1.00, the covering power is quite good, and this explains why, in the experiments which we made with the silk gauze and with the gum water, we got approximately the same covering power out of powdered glass that we did out of white lead. We have used glass as the illustration in many cases, because it would naturally be supposed that so transparent a substance as glass would have no covering power at all, but the same remark, to a greater or less extent, applies to the other semi-transparent pigments, such as sulphate of lime, barytes, talc, whiting, silica, feldspar, etc.

Another confirmation of the views above expressed is seen in this: Whitewash has no covering power so long as the water is with it, apparently because the index of refraction of the water and of the lime are so near alike. We have not succeeded in finding the figures representing the index of refraction of lime, but there seems little doubt that this is the correct explanation, since as soon as the water is evaporated, and we have air as the medium surrounding the particles, the covering power of whitewash becomes very good. It is also well known that if a piece of transparent glass is ground its power of transmitting light is very much diminished. If, on the other hand, the ground glass surface is covered with a layer of oil the power of transmitting the light becomes almost entirely restored, apparently because the index of refraction of the oil and of the glass are so near alike. Again, ordinary paper has more or less power of preventing the transmission of light, but when oiled it becomes, as is well known, quite transparent. In order to make these confirmations complete, it would need the figures for the indices of refraction of the various substances, but we have

not succeeded in finding this figure for all of the substances mentioned.

We are quite well aware that one or two points may be urged in regard to this view, that the difference between the refracting power of various pigments and the refracting power of the medium which surrounds them is the explanation of their covering power. It is, of course, hardly necessary to say that the index of refraction is simply the comparative measurement of the refracting power of different substances. One question which may be urged is that the experiments quoted from Von Bezold above only apply to transparent substances, and that therefore with any opaque substance there may be an additional element coming in. Upon this point we will say that there is much information which points in the direction that no substance is opaque, or, in other words, that all substances, in sufficiently fine state of division, are transparent. We think there is no doubt but that this subject needs further study—that is to say, the question of opacity as an element in covering power has not, to our knowledge, been thoroughly investigated, and we ourselves have not been able to make experiments enough to satisfy our minds on the subject. We certainly do have the positive evidence of experiment, that in transparent substances, if the medium surrounding the pigment has the same index of refraction as the pigment, the covering power is *nil*. If now all substances in the form of fine powder were more or less transparent, it is certain that the difference between the refractive power of the medium and the pigment will be an important element, and possibly the most important element in covering power. If, on the other hand, there is in some pigments an inherent quality, which even in a fine state of division prevents their transmitting light at all—a quality which we call opacity—this would unquestionably be an additional element in covering power. We are sorry not to be able to put this question at rest, but our means of experimentation, and the time which we could devote to this subject, have not been ample enough to enable us to do so. We incline to the view that all substances transmit light more or less, and that by far the greatest portion of covering power is simply a difference in the refracting power between the pigment and the medium surrounding it.

There are one or two other questions which are quite interesting in this connection. If, as seems to be proven fairly well, and as we are quite strongly inclined to think, the difference in the refractive indices of the pigments and the medium surrounding them is the principal element in covering power, the query arises, How wide a difference between these two indices is it necessary to have in order to have good covering power? Referring to the paragraph given above, glass has almost the same refractive power as linseed-oil; white lead shows a greater difference; chrome yellow and vermilion greater differences still. Does not the covering power vary directly in proportion to this difference? We have not yet been able to settle this question. It seems probable, however, from what experiments we have made that the wider the indices of refraction are apart the better the covering power, and this probably explains why, in the experiments cited above, the glass, the sulphate of lime, etc., did not have quite as good covering power as the white lead. The actual difference in covering power, when air is the medium surrounding the pigment, is not very great, but there was still a perceptible difference between white lead, glass, talc, whiting, sulphate of lime, barytes, silica, etc.

If the theory given above is correct, it is clear that the great desideratum in a pigment is high index of refraction, or a change in the liquid used for painting to one which has a lower index of refraction than linseed-oil. It is, of course, an interesting question as to whether by any means the index of refraction of various substances can be changed. We do not at present know of any such means of making the refractive power of linseed-oil less than it is, nor do we know of any means of increasing the refractive indices of substances which we want to use for pigments. It is possible that some of the linseed-oil substitutes might be more valuable than linseed-oil in this respect, but we have not yet had time to explore this field.

It seems fair to conclude, from the experiments and discussion detailed above, that the field for work in the future, so far as optical covering power of paints is concerned, is largely in the refractive indices of various substances, and so far as our knowledge goes the field is very largely unworked. We have been able to find very little information on the subject, and have not yet had time to carry out any extended studies in the field of refraction. Apparently the great desideratum in the pigment line today is some white substance capable of being easily crushed into a fine state of division, and which has a very high refractive index.

Our studies have also led us to the conclusion that there is another element in pigments which has an important influence on their optical covering power, and that is the state of division in which the pigment exists. We have made quite a number of experiments in this line, and in every case have we found that the covering power was improved by making the pigment finer. For example, taking glass to start with and crushing it to what may be called fair pigment condition in a mill; then rubbing it up somewhat in a mortar and taking out a sample; then rubbing it up still more and taking out another sample, and so on four or five times, each time getting a finer grade than before, we find that experiments on covering power, either with the silk gauze or with the gum water as described above, shows that in every case the finer the glass the better the covering power; and we have not yet found an exception to this in any of the pigments which we have experimented with. White lead, zinc white, chrome yellow, and, in fact, all of the good covering pigments are improved in covering power, if we may trust our experiments, by being reduced to a finer state of division. The importance of this statement to the practical manufacturer of paints is obvious, and will be referred to later.

It is perhaps not difficult to see why increased fineness should increase the optical covering power, if we consider optical covering power to be the power to prevent the transmission of light. Taking the case of the powdered glass, for example, the indices of refraction of that and air are sufficiently wide apart, so that fairly good covering power is obtained with a moderately coarse pigment; but the finer the particles are the more the light is broken up in its effort to get through the layer of pigment, and consequently more of it fails to get through to the eye, and the same is true of any other pigment. In other words, the fineness retards the passage of light, all other things being equal, and consequently helps the covering power.

It must be confessed that the outlook for the use of many of the cheap substances, such as sulphate of lime, barytes, feldspar, silica, talc, whiting, etc., is not very encouraging in view of the discussion above. The failure of these substances to have good covering power seems to be founded in laws of nature, and there is very little hope of any possibility of changing or avoiding these laws. We have, however, found in the course of our experimentation three possibilities, all of which are well known to the trade, but possibly not thoroughly appreciated for their full worth as means of getting fairly good covering power along with the use of some of these cheap pigments. These are as follows:

First. As has already been discussed, the fineness has an important influence on the covering power, and this is entirely within the control of the paint manufacturer in his grinding. The finer he grinds the paint the greater the covering power of the paint, whatever the pigment he may use, and this applies, we think, equally well to the pigments which are inferior in covering power as well as those which are better in this respect.

Second. We find by actual experiment that a certain percentage of pigment of good covering power, mixed with a certain percentage of pigment of inferior covering power, gives a resulting pigment which has almost as good covering power as the better one. We have been somewhat astonished at the results obtained. For example, 20.00 per cent. of zinc white with 80.00 per cent. sulphate of lime, carefully and finely ground, will give very fair covering power, and in fact almost as good as all white zinc. The same thing seems to be approximately

true of white lead and talc, or white lead and barytes. We have not yet positively fixed on the ratio between the inferior and better pigments which we are willing to abide by. Indeed, 10.00 per cent. of white lead mixed with 90.00 per cent. talc, the mixture being carefully ground, gives very much better covering power than would be expected. It is probable that the percentage of inferior pigment which can be carried by one of better covering power is variable, depending on the good pigment which is started with and on the substance which is mixed with it, and it would probably take an experiment in each case to decide the matter. We are confident, however, that the limit of good pigment that is necessary in order to get good covering power is lower than it has been the general practice of the trade to use. We will refer to this matter again in a subsequent article, and content ourselves here with putting on record the fact that a mixture of two pigments of good and inferior covering power can be made, which will give almost if not quite as good covering power as if the paint was made wholly of the better pigment.

Third. There is still another variable which can be made use of to improve the covering power in inferior pigments, and that is to diminish the amount of oil used when the paint is spread on a surface. A good paint has a ratio of pigment to liquid, when fit for spreading, of about one-third pigment to about two-thirds liquid by volume. This ratio may vary considerably either side of these figures, but this is an approximation based on quite a number of experiments. If now the volume of the pigment is increased in comparison to the volume of the oil, the covering power, all other things being the same, will be improved. The limit, of course, is the stiffness of the paint during application. In other words, too thick a paste cannot be spread, but there is a way out of this difficulty likewise. Starting with a paint mixed in the proportions of one-third pigment to two-thirds oil by volume, this ratio would be very nearly maintained when the paint was dry, since the dried linseed-oil changes very little in weight from the weight of the original oil started with. We are, of course, assuming a paint in which there is very little turpentine. On the other hand, it is quite possible to mix a paint for spreading, by using turpentine or some other volatile dilutant, so that when the paint is dry on the surface it will not have the ratio of one-third pigment and two-thirds oil, but possibly one-half pigment and one-half dry oil, or even two-thirds pigment and one-third dry oil. In the last case the paint would be what is technically known as "flat," but it is probably sufficient, and would give, we think, fully as durable and perhaps better results if the ratio between the pigment and the dry oil on the surface was approximately half and half pigment and dry oil, and, as said above, if our experiments may be trusted, this procedure will improve the covering qualities whatever pigment is made use of.

In the next article we will try to discuss the question of how to design a paint.

(TO BE CONTINUED.)

THE UNITED STATES NAVY.

GOOD work has been done by the Naval Institute since its organization, and many valuable papers have been the result of the opportunity presented to naval officers for a hearing. Perhaps not the least of this work is the active and somewhat sharp discussion stirred up by a recent paper read before the Institute on naval organization and training. Perhaps neither party in this is altogether in the right, but the discussion cannot fail to do good, since the best way to secure improvement is to draw attention to the weak spots and defects in the existing structure. Our Navy is in a transition state, and the change must be accompanied with some friction, but the adaptation of the organization to the new methods is only a question of time.

TRIAL OF THE "CONCORD."

The speed trial of the new gunboat *Concord* took place January 13, when the vessel made a run of 4½ hours through Long Island Sound and the Atlantic from a point off Matinecock Light to a point some 10 miles northeast of Montauk. The contract for the *Concord* was not based on speed, as with most of the other cruisers, but upon the power developed by the engines, which were required to indicate at least 3,400 H.P. The official report has not yet been published, but it is understood that the engines indicated over 3,500 H.P., thus earning a premium for the builders. The average speed during the four hours accepted as the trial hours was about 16 knots an hour, and the highest speed attained during any one hour was 16.8 knots, which was done on 153 revolutions per minute of the engines, the average for the four hours being 151 revolutions for the forward engine and 152.5 for the after engine. The steam pressure was well maintained, averaging about 160 lbs. throughout the trial and being 168 lbs. at its close.

The *Concord* is a twin screw gunboat of 1,700 tons displacement, and is 230 ft. long and 37 ft. beam, with a mean draft of 14 ft. The contract for the ship was taken by N. F. Palmer, Jr., & Company, of New York, the hull being built in the Roach yards at Chester, and the engines at the Quintard Works in New York.

The engines are triple-expansion, but are of a horizontal type instead of the vertical type which is used in most of the new cruisers. The cylinders are 22 in., 31 in. and 50 in. in diameter with a 30 in. stroke, and are placed in separate water-tight compartments. The valves are all piston-valves worked by radial gear. The air-pumps, feed-pumps, etc., are driven independently of the main engine, and steam reversing gear is also provided for the main engine. The surface condensers are cylindrical in form and of the usual construction.

During the trial it is stated the engines worked very freely and without the slightest difficulty, and the boilers also steamed very freely.

Foreign Naval Notes.

A FRENCH SUBMARINE BOAT.

THE submarine torpedo-boat *Gymnote* has lately had a particularly interesting trial at Toulon. The object was to see if the boat could run out of and re-enter the port in spite of a close blockade kept up by the ordinary torpedo-boats. With this intention the torpedo-boats were stationed in such a way as to watch carefully for the *Gymnote* and to pursue her, if seen. The submarine boat, however, passed out of the port and started along the shore, her submersion lasting 40 minutes, so that she was 2½ miles from the entrance to the port when she returned to the surface, that distance having been run in a straight line. After reconnoitering the position the *Gymnote* was again submerged and returned directly to the port. This time she passed directly under one of the blockading vessels, and was seen, but only for an instant, and then so indistinctly that it was impossible to note her course or to follow her. This experience is regarded as conclusive.

A JAPANESE COAST DEFENSE SHIP.

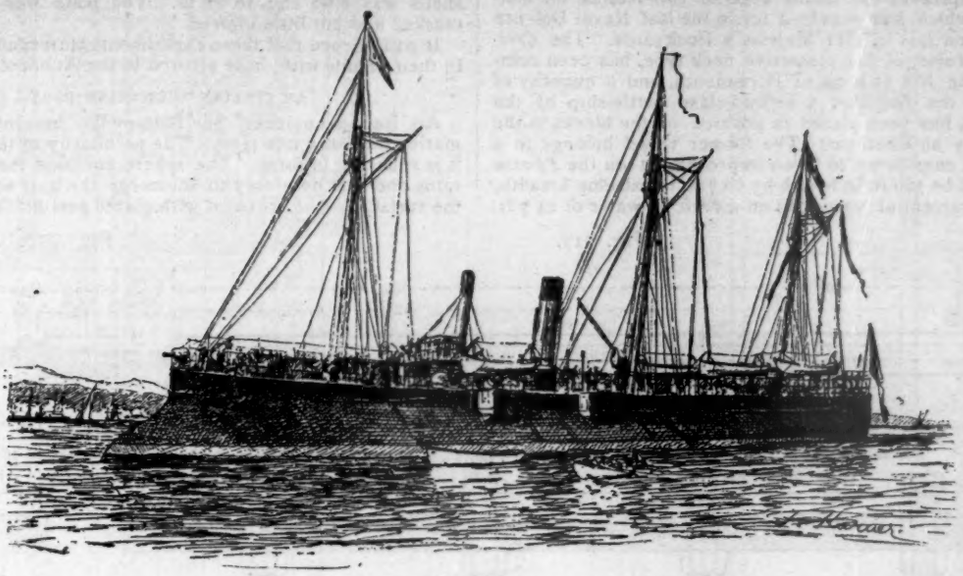
The accompanying illustration, from *Le Yacht*, shows the coast defense ship *Itsukushima*, built for the Japanese Government by the Société des Forges et Chantiers at La Seyne, France, which recently received its preliminary trials at Havre. This vessel is a steel ship with armored deck, and carrying a heavy armament, intended for coast defense purposes. Its general dimensions are: Length, 295.20 ft.; extreme breadth, 50.87 ft.; depth, 34.87 ft.; mean draft, 19.84 ft.; displacement, 4,277 tons.

The armament consists of one 12.6-in. gun of the Canet type, which is carried in a turret forward. This gun is 38 calibers in length and weighs 65 tons. There are also eleven 4.7-in. rapid-five guns, eight carried in sponsons on the main deck, one aft and two forward, and eleven 1.45-in. rapid-five guns as a secondary battery. The turret has armor 11.8 in. thick, and its base is protected by a barbette covered with 4-in. armor. The rapid-fire guns as well as the 12.6-in. gun are of the Canet type. The offensive power of the ship is thus very considerable, while its machinery and boilers are protected by the armored deck, by the coal bunkers, and by compartments filled with cellulose.

On the preliminary trials the ship attained a speed of 15.7 knots with natural draft and of 17 knots with forced draft, the engines working remarkably well and the supply of steam from the boilers being abundant.

The Japanese Government has now under construction in France the *Matsushima*, a sister ship to the one just described

while a third is being built in the Navy Yard at Yokoska, in Japan. It has also building in France two torpedo cruisers of



NEW CRUISER "SURCOUF," FOR THE FRENCH NAVY.

700 tons displacement. This is in addition to two cruisers recently built in England.

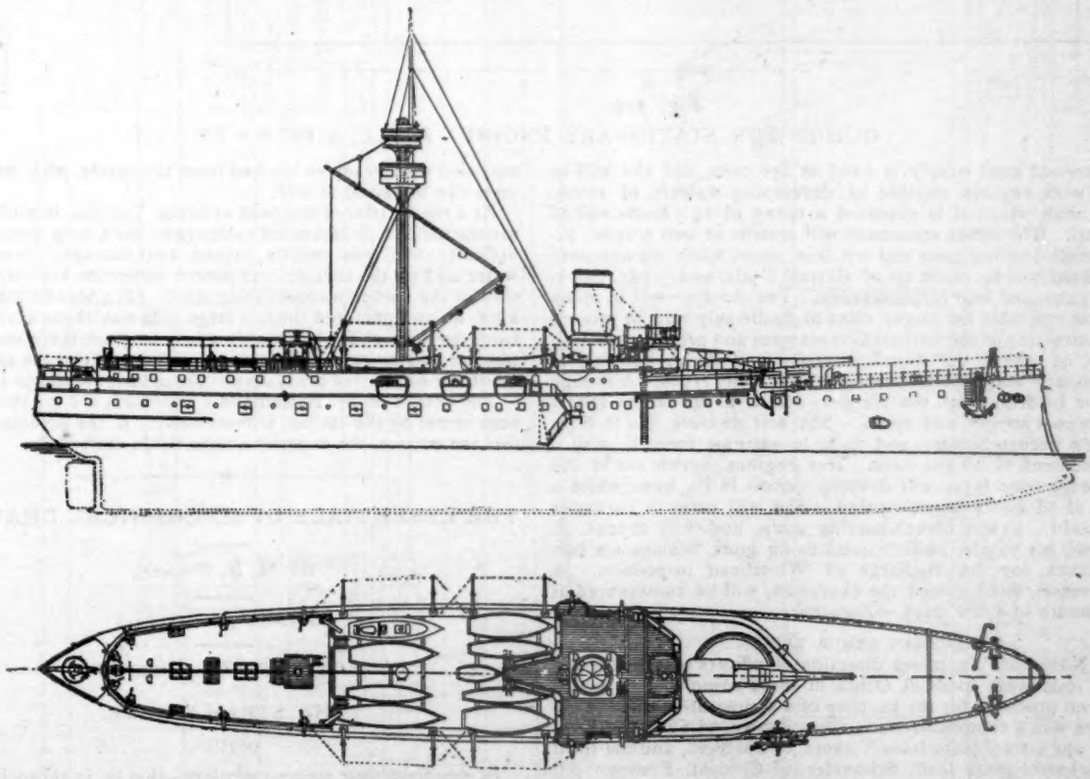
A FRENCH FAST CRUISER.

The accompanying illustration, from *Le Yacht*, shows the French third-class cruiser *Surcouf*, which recently had her speed trials. The *Surcouf* is 95 meters (311.75 ft.) long; 9.30 m. (30.5 ft.) greatest breadth; 6.54 m. (21.5 ft.) depth, and has a mean draft of 4.24 m. (13.9 ft.).

The two engines are of the horizontal compound type, having cylinders 0.935 m. (36.71 in.) and 1.879 m. (74.18 in.) in diameter, by 0.915 m. (36 in.) stroke. Working at full power they make 135 revolutions, giving a piston speed of 4.12 m. (13.51 ft.) per second. Each cylinder has two piston-valves worked by Marshall gear. The reversing, etc., is done by a small steam-engine.

There are six boilers each 2.92 m. (9.58 ft.) in diameter and 5.80 m. (19 ft.) long. Each boiler has two fire-boxes and a grate surface of 48.44 sq. ft. The heating surface is 2,349 sq. ft. The usual working pressure is 192 lbs. In the preliminary trials these boilers vaporized 8.8 lbs. of water per pound of coal burned.

On a six-hour trial with natural draft the engines developed 3,508 H.P., giving the ship a speed of 17.3 knots. With 1,800 H.P. developed, the fires being kept low, a speed of 15 knots was reached. With forced draft, on a two-hour trial, a speed of 20.51 knots was reached, the engines making 133 revolutions, and developing 6,287 H.P. The contract under which these engines were built called for 6,000 H.P. with forced draft, so that the requirements were exceeded.



JAPANESE COAST DEFENSE SHIP "ITSUKUSHIMA."

NEW SHIPS FOR THE BRITISH NAVY.

During the present month the keels of two vessels, the construction of which was provided for in the last Naval Defense Bill, have been laid in Her Majesty's Dockyards. The *Crescent*, a steel cruiser of the protective deck type, has been commenced in the No. 11 dock at Portsmouth, and a quantity of material for the *Barfleur*, a second-class battle-ship of the barbette type, has been placed in position on the blocks in the No. 7 slipway at Chatham. The former vessel belongs to a type which is considered to be an improvement on the *Phæton* class, and will be 360 ft. in length by 60.7 ft. in extreme breadth, with a displacement of 7,700 tons on a draft of water of 24 7 ft.

Her normal coal supply is fixed at 850 tons, and she will be fitted with engines capable of developing upward of 12,000 H.P., with which it is expected a speed of 19 5 knots will be realized. The main armament will consist of two 9.25 in. 22-ton breech-loading guns and ten 6-in. guns, while the auxiliary armament will be made up of sixteen 6-pdr. and 3-pdr. quick-firing guns, and four torpedo tubes. The *Barfleur* will in many respects resemble the larger class of battle-ship now in process of construction at the various Government and private establishments, of which the *Royal Sovereign* and *Hood*, building at Portsmouth and Chatham respectively, are types. Although inferior in armament, the *Barfleur* will rival her larger sisters both in coal supply and speed. She will measure 360 ft. 6 in. between perpendiculars, and 70 ft. in extreme breadth, with a displacement of 10,500 tons. Her engines, which are of the triple-expansion type, will develop 12,000 H.P., from which a speed of 18 knots is anticipated. She will carry in barbettes four 10-in., 29 ton breech-loading guns, and will mount, in addition, ten 36-pdr. and 17 quick-firing guns, besides six torpedo-tubes for the discharge of Whitehead torpedoes. A sister vessel, to be named the *Centurion*, will be commenced at Portsmouth in a few days.—*Industries.*

RUSSIAN ARMOR TRIALS.

On November 11, under direction of officers of the Russian Navy, tests were made at Ochta of three armor-plates, which had been procured for the purpose of a comparative trial. One of these was a compound plate, from Brown, of Sheffield, England; one a steel plate from Vickers, of Sheffield, and the third a nickel-steel plate from Schneider, of Creusot, France. All were of the same thickness. Each received five blows, the projectiles used being 5.9-in. Holtzer chrome-steel shells, weighing 90 lbs. each; the first and second were fired with a velocity of 1,900 ft., the other three 2,100 ft.

In the compound plate the first two shells penetrated 13.4 in.; the other three passed through the plate and backing and fell some distance beyond. The plate was very badly cracked.

In the Vickers plate the greatest penetration was 20.9 in.; the plate showed only light cracks.

The Schneider plate stopped all five of the projectiles and broke three of them. The penetration of the two unbroken shells was 8.66 and 10.63 in. The plate was very slightly cracked and but little injured.

It will be seen that these experiments correspond very closely in their results with those secured in the Annapolis tests.

AN ITALIAN SUBMARINE BOAT.

An Italian engineer, Sr. Balsamello, has invented a submarine boat of a new type. The peculiarity of this boat is that it is spherical in form. The sphere contains the motive apparatus and that necessary to submerge the boat and return it to the surface. It is provided with glazed port-holes, or windows, and also with grapples worked from the inside, with which objects can be seized at will.

At a recent trial of this boat at Civita Vecchia, it worked very satisfactorily. It remained submerged for a long time without difficulty, and was readily turned and managed, both under water and on the surface. It passed under the keel of a battle-ship in the harbor without being seen. On a second trial of this kind, at an appointed time, a large raft was thrown overboard from the deck of the battle-ship; in a moment there was an explosion and the raft was blown to pieces, while at the same moment the submarine boat came to the surface about 130 ft. away.

The details of Sr. Balsamello's invention are for the present kept secret by the Italian Government. If the accounts of the test are correct, she must be a formidable craft.

Fig. 217.

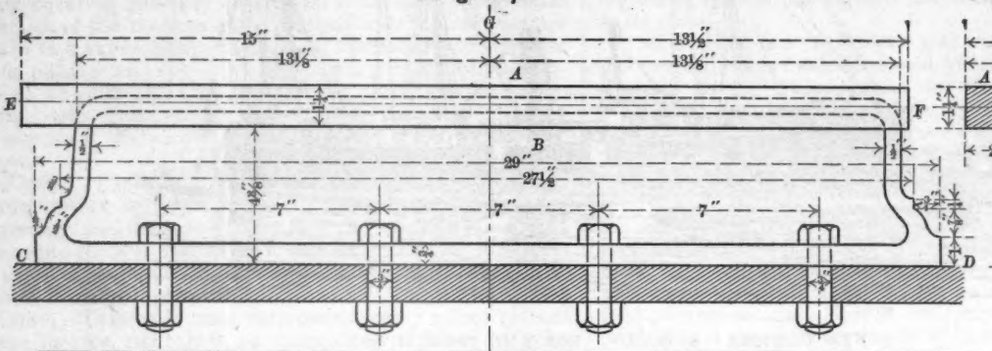


Fig. 218.

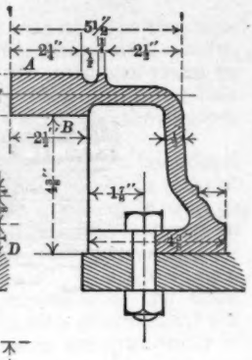


Fig. 219.

GUIDES FOR STATIONARY ENGINE. SCALE, 2 IN. = 1 FT.

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page 41.*)

CHAPTER VII.—(*Continued.*)

THE STEAM-ENGINE.

GUIDES.

In double-acting steam cylinders—that is, in those in which steam is admitted on both sides of the piston—it is essential that the piston-rod should be made so as to be capable of working steam tight where it passes through the cylinder head. To do this, it must always move in a straight line. By reference to Plate II, fig. *A*, it will be seen that when the crank is in any other position excepting the two dead-points, the connecting-rod is inclined to the longitudinal center line *A B*, passing through the piston-rod and cylinder. Consequently, the steam pressure which is transmitted to the crank by the connect-

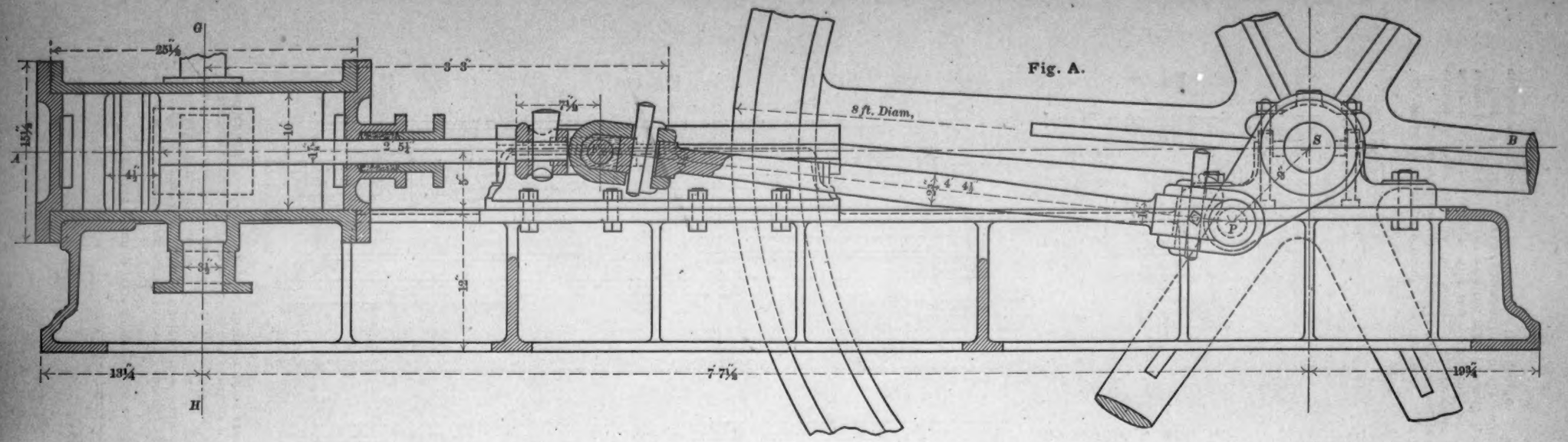


Fig. B.

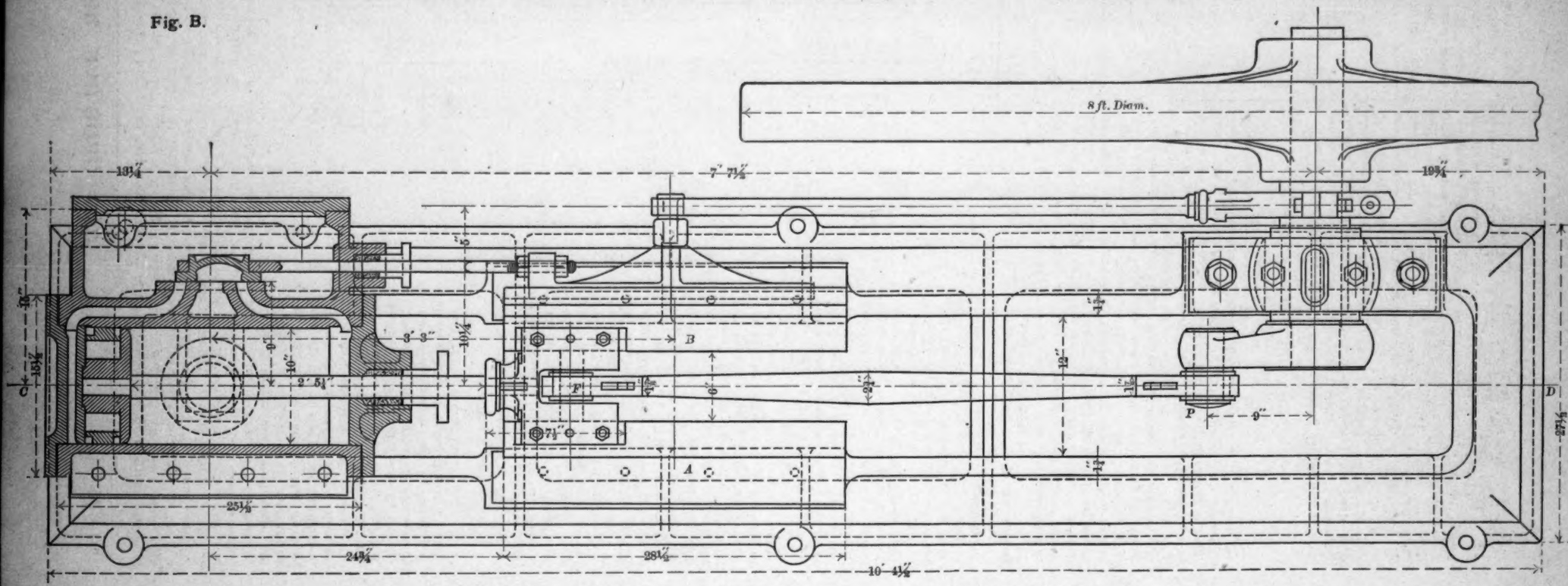


PLATE II. STATIONARY ENGINE, 10-INCH CYLINDER. SCALE, 1 IN. = 1 FT.

BUILT BY THE FISHKILL LANDING MACHINE WORKS, FISHKILL-ON-HUDSON, N. Y.

ing-rod causes the latter to exert an upward or a downward pressure on the end of the piston-rod, and if it was not supported in some way this pressure would "spring" the rod and cause it to diverge more or less from a straight line while it is moving. As has been explained, a sliding block, or cross-head, is attached to the end of the piston-rod, to cause the latter to move in a straight line. The cross-head has bearings which slide on bars, called *guide-bars*, fastened to the engine frame or cylinder, so as to be exactly parallel to the center line of the cylinder. The lateral pressure on the end of the piston-rod is transmitted to these bars by the bearings of the cross-head, which slide on the guide-bars, and the piston-rod must, therefore, move in a line coincident with the center line of the cylinder.

Figs. 217, 218 and 219 represent one of the guide-bars of the engine which has been illustrated in this chapter. This is made of cast iron, although in some classes of engines they are often made of wrought iron or steel. Fig. 217 is a side view looking at the guide-bar from the inside of the engine; fig. 218 is a transverse section, and shows the form of the casting, and fig. 219 is a plan. The student should draw this half size. It is bolted to the engine frame by the four bolts which are shown. The slides work on the top *A* and bottom *B* of the bar, which is planed and filed so as to be perfectly straight. In drawing the guide-bar, a horizontal line, *C D*, should first be laid down, representing the top of the frame. The distance from the top of the frame to the center-line of the cylinder should be ascertained, and the line *E F* drawn. From these two lines various dimensions may be laid off. A vertical center-line, *G H*, should also be drawn, as shown in the engraving, from which other dimensions can be measured. The method of doing this will be obvious from the engravings.

Fig. 220.

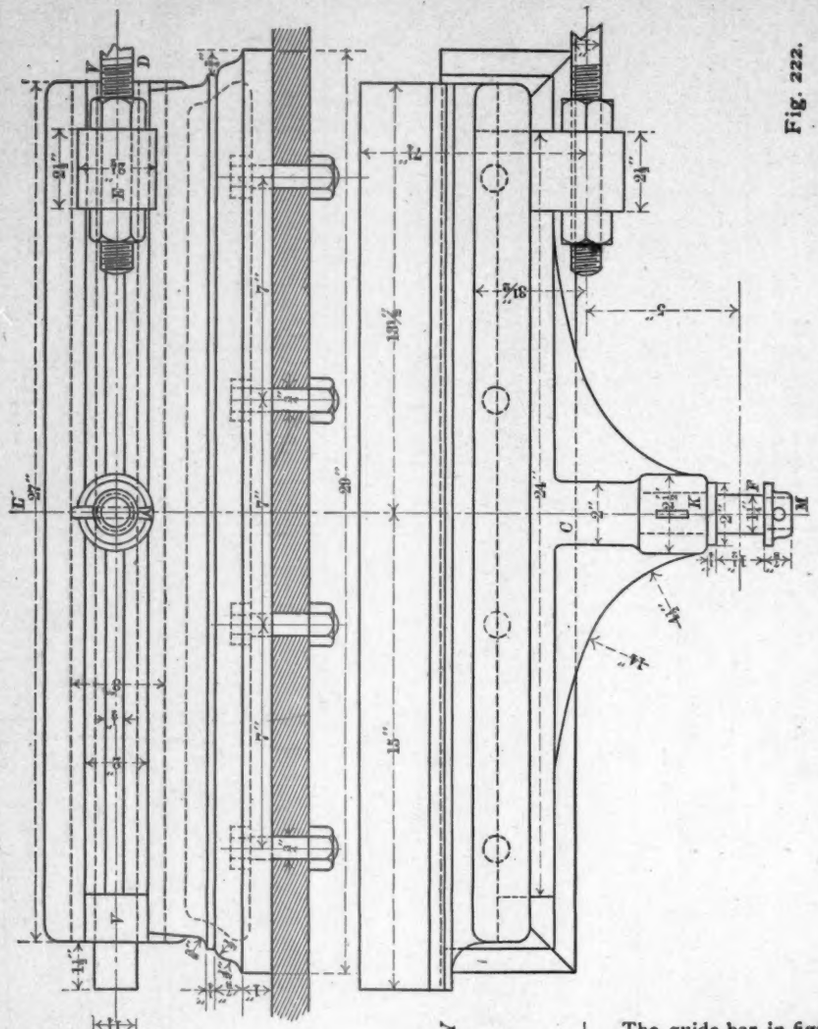


Fig. 221.

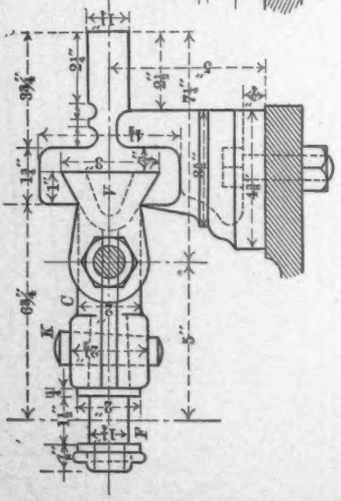


Fig. 222.

VALVE-STEM GUIDE FOR STATIONARY ENGINE. SCALE, 2 IN. = 1 FT.

VALVE-STEM GUIDE.

What has been said of the piston-rod is equally true of the valve-stem of an engine. It must also work steam tight through the end of the steam-chest, and the motion of the eccentric must be communicated to it by the eccentric-rod. Besides this, the center line of the eccentric, as shown in the plan fig. *B*, Plate II, is usually further from the center of the engine than the center of the valve-stem is. Consequently, their center lines are not "in line," or coincident with each other, and, therefore, the motion of the eccentric must be transmitted laterally. This makes some form of guide necessary for the valve-stem, as well as for the piston-rod. Such a guide is shown in figs. 220, 221 and 222, which represent the guide-bar *B*, fig. *B*, Plate II, which is opposite to *A*, the one illustrated by figs. 217–219. These two bars are similar to each other, excepting that the one has a guide, *C*, for the valve-stem and the other has not. This guide consists of a sliding piece *C*, which works in a V-shaped groove *V V'* in the casting which forms the guide-bar. The valve stem *D* is fastened by two nuts to a lug *E* on the front end of the slide. The eccentric-rod is connected to the pin *F*, which fits into a tapered hole in the sliding pin and is held by a key *K*.

The guide-bar in figs. 220–222 is drawn in the same way as the one shown in figs. 217–219. The horizontal center line of the valve-stem slide coincides with that of the cylinder and piston-rod. A vertical center line *L M* should be laid down which passes through the center of the eccentric-rod pin, as shown in figs. 220 and 222. In the plan, fig. 222, and the end view, fig. 221, the center lines of the eccentric-rod and the valve-stem should be laid down as indicated by the figures, and these two rods should be drawn on these lines.

The eccentric-rod has an eye on its front end by which it is connected to the pin *F*. This eye has a steel bushing, or ring, fitted into it which can be removed and replaced by a new one when it becomes worn. Sometimes a strap-end is used on the eccentric-rod instead of an eye.

GENERAL DRAWINGS OF A STEAM-ENGINE.

The student, having drawn the details of an engine, is now prepared to assemble the various parts and draw the complete engine. To show the construction of the various parts, it is advisable to show some of them in section. Thus, instead of representing a side view of the whole machine, it is best to draw a longitudinal section, as in fig. *A*, Plate II. In the plan, fig. *B*, Plate II, a section of the cylinder steam-chest and valve is shown, and a top view of the other parts. In both cases the sections are drawn on the center line of the cylinder.

The complete or *general drawings*, as they are called, shown in Plates II and III, should be drawn by the student to a scale of two or three inches to a foot. In making these drawings the first thing to do for figs. *A* and *B* is to lay down the longitudinal

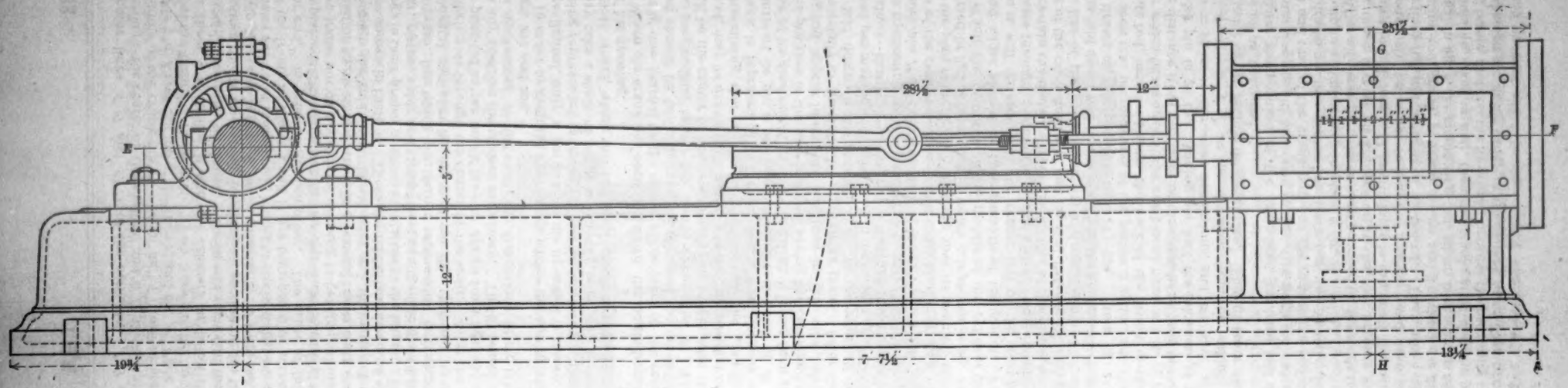


Fig. A.

Fig. D.

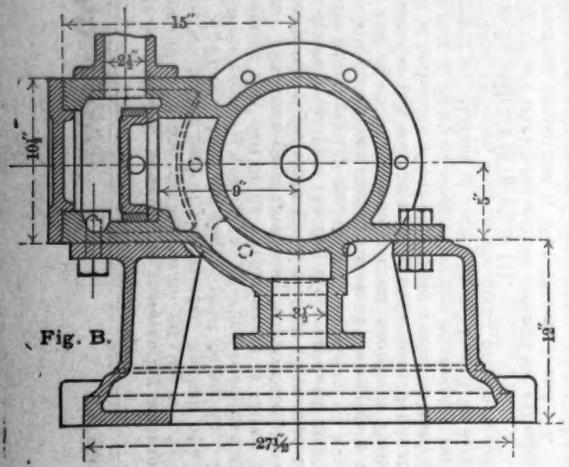


Fig. B.

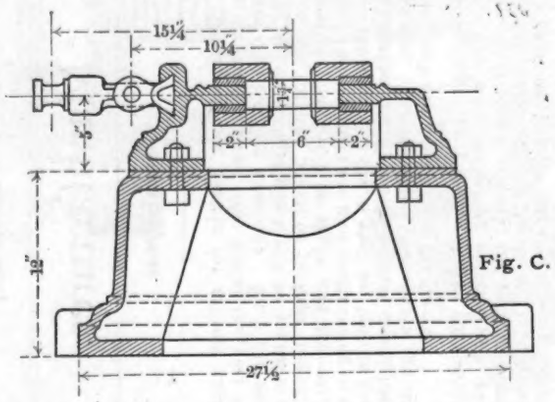


Fig. C.

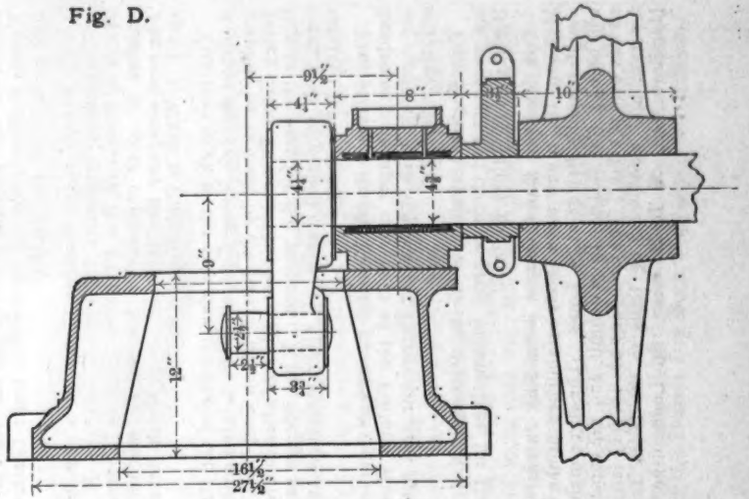


PLATE III. STATIONARY ENGINE, 10-INCH CYLINDER. SCALE, 1 IN. = 1 FT.

BUILT BY THE FISHKILL LANDING MACHINE WORKS, FISHKILL-ON-HUDSON, N. Y.

center lines *A B* and *C D* of the cylinder. *A B* will pass through the center of the shaft *S*, and *C D* passes through the middle of the crank-pin *P*. From fig. *A* it will be seen that *A B* is 5 in. above the top of the frame, and fig. *A*, Plate I, shows that the frame is 12 in. deep. Two lines parallel to *A B*, one of them 5 in. below it and the other 12 in. below the latter, should, therefore, be drawn. These will represent the top and bottom of the frame. A longitudinal section of the frame can then be drawn in fig. *A*, and a plan in fig. *B* from the different views shown in Plate I. It should be noticed that the positions of the frame in Plates I and II are transposed or turned, "end for end," in relation to each other. The cause of this will be explained further on, but the learner must be careful in laying the frame out on his general drawing to get its position right in relation to its other parts. The vertical center lines which pass through the middle of the cylinder and the center of the shaft are shown in Plate I. These should be laid down on the drawings in their proper position in relation to the frame. The cylinder, piston, valve and steam-chest can then be drawn from figs. 207–216, for which no further explanation is required. The pedestal can also be drawn from figs. 198–200 on the lines which pass through the center of the shaft. After the pedestal is penciled in the crank may be drawn from figs. 186 and 187, in any position the student may fancy. The fly-wheel may also be represented on the shaft, the dimensions being taken from figs. 201 and 202.

In order to keep the engravings within the size to which they are limited, only a portion of the fly-wheel is shown, the rest being represented as though it was broken away. The student may take a sheet of paper sufficiently large and represent the whole wheel, which will add considerable to the pictorial effect of his drawing.

When the crank has been laid down, the length from the center of one journal to the center of the other of the connecting-rod should be laid off from the center of the crank-pin *P*, on the longitudinal center line of the cylinder at *F*. This point will be the center of the cross-head pin, which, with the cross-head, may be drawn from figs. 203 to 206, the position of the pin determining that of the other parts. In the plan fig. *B*, the crank is represented in the position it would occupy when the center of its pin is on the horizontal center-line *A B*, or is at one of its *dead-points*, as they are called. It has been shown in this position in the plan to avoid having the crank and connecting-rod appear in inclined positions in this view, which adds materially to the difficulty of drawing them. After the crank is laid down in this position in fig. *B*, the center of the cross-head pin may be laid down at *F* in the same way as has been explained—that is, by measuring a distance equal to the length of the connecting-rod from center to center, from the center of the crank-pin *P* on the center line *C D* to *F*, which will be the center of the cross-head pin. The cross-head may then be drawn in the plan from fig. 204, noticing that its position must be reversed in fig. *B* from that in which it is shown in fig. 204.

When the piston is in the middle of the cylinder the cross-head slides should be in the middle of the guides. From fig. 204 it will be seen that the center line of the cross-head pin passes through the middle of the slides. Consequently, if we ascertain the distance from the middle of the piston to the center of the cross-head pin, and lay that distance off from the middle line of the cylinder, on its horizontal center line, the point thus laid down will be the middle of the guides, which may then be drawn on this line from figs. 217–222. From fig. 215 it will be seen that the thickness of the piston is $4\frac{1}{2}$ in., and the length of its rod, measured from the back of the piston to the shoulder which bears against the cross-head boss, is 2 ft. $5\frac{1}{2}$ in.; and the distance from the front of the cross-head boss to the center of its pin is $7\frac{1}{2}$ in. Adding one-half the thickness of the piston $= 2\frac{1}{4}$ in. to the other dimensions, and we have $2\frac{1}{4}'' + 2'\ 5\frac{1}{2}'' + 7\frac{1}{2}'' = 3'\ 3''$ = the distance from the middle of the cylinder to the middle of the guides. This distance should be laid off as described.

After the position of the cross-head has been laid down, a center line should be drawn in fig. *A* through the center of its pin and that of the crank-pin, and the connecting-rod can then be drawn on this center line from figs. 193 to 196. It can be shown in a similar way in plan in fig. *B*.

After all these parts have been penciled in, the student should ink those first which are nearest to the eye, because these are shown in full lines. If he attempts to ink in all the parts simultaneously, he is apt to become confused and draw some of the lines full which ought to be dotted. Thus, when the connecting-rod, crank, pedestal, frame and fly-wheel are drawn in pencil in fig. 8, the connecting-rod, which is nearest to they eye, should be inked in first, then the crank, after that the pedestal and frame, and last the fly-wheel, because the proximity of these to the eye are in the order in which they have been named.

It is desirable, however, in representing a steam-engine to show the valve and mechanism for moving it. As in this case these are on the back of the cylinder, another, or a back view, fig. *A*, Plate III, of the engine must be shown. In order to show the eccentric clearly, the fly-wheel is omitted in this view, excepting that part of its circumference is shown by a dotted line. The steam-chest cover and the valve are also omitted, in order to show the steam ports clearly. The eccentric and rod are drawn from figs. 189–192, the cross-head and valve-stem guides from figs. 217–222.

It will be noticed that this view of the engine is turned end for end from that in which it was shown in Plate II. The reason for this will be readily understood if the student will look at both sides of any object, say a wheelbarrow, and he will find that if views of both sides are represented they must be reversed in relation to each other. It will be seen, too, that the frame, cylinder, etc., in the detail drawings, are shown in the same position as in Plate III.

Fig. *B* is a transverse section through the cylinder drawn on the vertical center line *G H* of Plates II and III. Fig. *C* is a transverse section through the guides, and fig. *D* a similar section on the center line of the shaft. The student should have no difficulty in drawing these views from the detail drawings.

(TO BE CONTINUED.)

Manufactures.

General Notes.

A NEW electric lighting system for railway cars is to be placed on the market some time during the year 1891 by the Consolidated Car Heating Company. Each car will have an independent source of light which will be available even when the car is at rest for five hours, or perhaps longer. The tax upon the motive power will be slight and indirect, no steam being used. The designers are now endeavoring to so simplify and cheapen the apparatus that it shall be, both in first cost and in running expense, more economical than any lights now used in first-class cars. The system will include storage batteries and a dynamo on each car, driven from the car axle.

THE Rhode Island Locomotive Works, in Providence, are building six four-wheel switching engines with 16 × 24-in. cylinders for the Boston & Albany, and 10 eight-wheel engines, with 18 × 24-in. cylinders, for the New York, New Haven & Hartford. These works have just completed a compound locomotive with high-pressure cylinder 18 × 24 in., low-pressure 28 × 24 in., driving-wheels 78 in. in diameter, boiler 52 in. diameter of barrel, and fire-box 78 in. long. This engine is intended for fast passenger service on the Georgia Southern & Florida Railroad, but will be tried on some Eastern roads before going to its destination.

THE Pennsylvania Machine Company, a new organization, will hereafter represent in Philadelphia the H. B. Smith Machine Company, the Fitchburg Machine Company, and a number of other concerns in the general machine business. The new company has its offices at 29 North Seventh Street, and J. J. White is President.

THE iron work of the new elevated line of the Pennsylvania Railroad through Jersey City will all be painted with the silica-graphite paint made by the Joseph Dixon Crucible Company in Jersey City. This paint has been adopted after careful examination as the best for the purpose. It has been in use for some time, with very good results, on other structures, where it has received severe tests.

THE Missouri Pacific Railroad has recently put in service 12 handsome passenger cars built at the Pullman Works. They are equipped with the Scarritt-Forney car seat with the new adjustable foot-rest.

THE Rogers Locomotive Works, Paterson, N. J., are building 25 mogul and three decapod locomotives for the Chicago, Burlington & Quincy Railroad.

THE Madison Car Company is building extensive shops in Madison, Ill., a new town lately established at the east end of the Merchant's Bridge at St. Louis. The three main buildings will be 650, 800 and 935 ft. in length, and the capacity will be 26 box cars per day. The Company has let very large contracts for iron and wood-working tools to the Niles Tool Works, Hamilton, O.; A. B. Bowman, St. Louis; the Blakeslee

Manufacturing Company, Cleveland, O; J. A. Fay & Company, Cincinnati; Greenlee & Company, Chicago, and the Berry & Orton Company, Philadelphia. The engines, boilers and similar work will be furnished by the Rankin & Fritsch Company and John O'Brien & Company, of St. Louis.

It is stated that the process for producing aluminum direct from the ore adopted by the Cowles Electric Smelting & Aluminum Company has been so improved that the metal 98 per cent. pure can be produced at a cost of $1.25 per lb. It is proposed to give up the production of iron and copper alloys at the Lockport Works, and to use the entire plant there in the manufacture of pure aluminum. The output will then be from 1,000 to 1,500 lbs. per day.

Three locomotives from the Baldwin Works were recently put in service on the Philadelphia Division of the Baltimore & Ohio Railroad. They are eight-wheel passenger engines, with cylinders 20 × 24 in., driving-wheels 78 in. and truck-wheels 36 in. in diameter.

The Great Western Construction Company has been organized to build works in Chicago for the manufacture of locomotives on a plan devised and patented by Hugh R. Walker, which relates chiefly to the arrangement of the fire-box. The incorporators are Hugh R. Walker, Alfred Skinner and Thomas A. Winham.

The Midgley Wire Belt Company, Beaver Falls, Pa., is making an increased amount of wire-belting; an order has been received from the Government for a sample of torpedo netting.

The plant of the Ryan & McDonald Company, manufacturers of contractors' tools, cars, etc., is being removed from Waterloo, N. Y., to South Baltimore, where a shop, 70 × 350 ft. in size, is nearly finished.

The Pullman Sash Balance Company, Rochester, N. Y., has presented a new device for windows which seems to work very well indeed. It is being introduced on a number of roads.

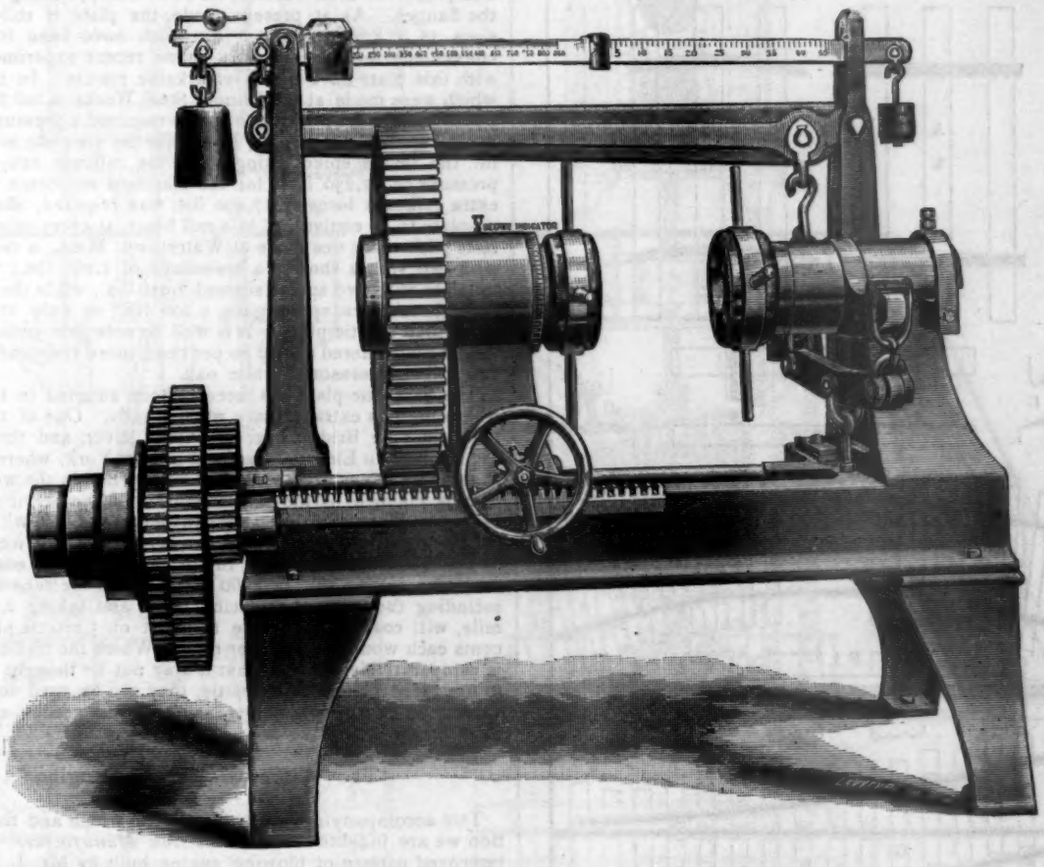
The engines for the Lighthouse tender *Marigold*, recently completed by the Detroit Dry Dock Company, Detroit, Mich., are of the direct-acting, vertical, triple-expansion type, with cylinders 14½, 22 and 36 in. in diameter, and 24 in. stroke. Steam is furnished by two steel boilers, 10 ft. 6 in. in diameter and 10 ft. 10 in. long. The boat is 159 ft. 6 in. long; 27 ft. beam; 12 ft. deep, and draws 9 ft. 10 in. of water.

The new "U. S. automatic block signal," which has been tried on several roads, is now controlled by the Martin Anti-Fire Car Heater Company, of Dunkirk, N. Y., and that company will shortly be prepared to put it on the market.

An Improved Torsional Testing Machine.

The accompanying illustration shows a new torsional testing machine with iron frame, manufactured by the well-known firm of Riehle Brothers in Philadelphia. The general arrangement and construction is well shown in the cut.

The fixed head carrying self-centering grips has arms 1 ft. in length, projecting either side of the grip-head, which is supported on a knife-edge. To prevent the grip-head from lifting from its position these arms are connected to an equalizing lever underneath, and this in turn connects the weighing beams, where the strain is recorded in foot-pounds without any calculation on the part of the operator. The cone pulley has four sizes and is driven from a countershaft, which should not run faster than 30 or 40 revolutions per minute.



RIEHLE'S IMPROVED POWER TORSIONAL TESTING MACHINE.

This machine is constructed entirely of iron, steel and brass, and is of handsome design and finish. The levers and weighing beam are adjusted to the United States Government standard. Its general dimensions are: Extreme height, 3 ft. 10 in.; extreme length, 6 ft. 4 in.; extreme width, 3 ft.; weight, 2,100 lbs. Specimens can be 20 in. long or less; they can be 1¼ in. square, or round with square ends, or of less size. The motion of the head is 12 in.; the capacity, 5,000 lbs. A modification of the design enables the power to be applied by hand, although it is considered much better to run the machine by power, if possible.

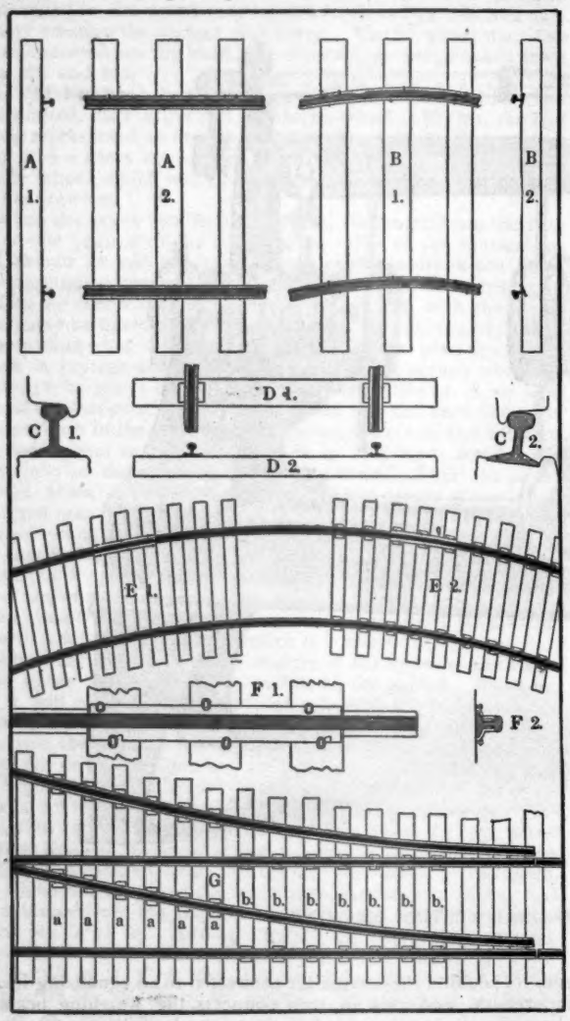
This pattern of testing machine has met with unexpected favor since the first one was completed. The makers have

furnished machines of this pattern which are now in use by the Union Pacific Railroad at Omaha; the Thomson-Houston Electric Company, Lynn, Mass.; the State College of Pennsylvania; Clark University at Worcester, Mass.; the Russian Government and the Brazilian Government.

The Use of Tie-Plates.

MANY plans have been considered for prolonging the life of ties, the renewal of which forms so large an item in the expense of maintaining a railroad. In many parts of the country it is difficult to get hard-wood ties, while in others local causes lead to rapid decay. The different processes of wood preservation have not come into general use, and in any case they would not prevent one cause of the rapid deterioration of the tie, the cutting of the rail.

One of the most effectual devices that has so far been brought into use is the use of the tie-plate, or flat plate of metal interposed between the tie and the rail. The use and advantage of this may be illustrated by the accompanying sketches, where they are shown in special positions. In many cases extra spikes



are driven to prevent spreading of the rails, and when the wheels are on the same the rails tend to cant as shown in *A*1 and *A*2. On curves, especially where soft-wood ties are used, there is a tendency for the inner rail to turn over, as shown in *B*1 and *B*2. This tendency widens the gauge and causes more or less danger of derailment of trains. Where a tie-plate is used, as shown in *D*1 and *D*2, the tie will not be cut by the rail-base, the gauge will be preserved and the rail-head will be in correct position to give a good bearing to the wheels, as shown in *C*1, instead of cutting into the tie, widening the gauge and destroying the tie, as shown at *C*2. Another case of the use of the tie-plate is shown at *F*1, on heavy grades and with the outside rail on curves, where the slot in the inside angle-bar frequently wears rounding, allowing the spike to slip out of and by the slot, and permitting the rail to move. In fig. *E*1 a case of this kind is shown, where the rail has moved, carrying the ties with it, making the support uneven and throwing the track out of line. This necessarily caused more or less oscillation to the train and at the same time increased repair to track. Where the tie-plate is used, as in fig. *E*2, the ties remain in place and little or no movement of the rail is possible. If the tie-plate is made of the proper length and the holes for the spikes punched directly to agree with the slot holes in the angle-bar the spikes will afford material help in keeping the rails in place and upright.

All who have had to do with the maintenance of track will appreciate the use of tie-plates in switches. Fig. *G* illustrates this. Where the main traffic comes on the curved rails the plates should be placed as shown in *a a a*, but where the straight track is the main track, they should be placed as shown in *b b b*. Their use is further desirable in this case, as they tend to prolong the life of the switch ties, which are of unusual length, and generally much more expensive than the ordinary ties.

It is to meet this demand for support to the rail that the Servis tie-plate has been devised. It is rolled of steel and provided with a flange which prevents it from buckling under the rail so that it becomes practically a part of the tie. By giving an extended bearing it prevents cutting of the ties, as noted above, and preserves their surface, its own stiffness being secured by the flanges. As at present made, the plate is rolled in two sizes, $3\frac{1}{2} \times 8$ in. and 6×8 in., which have been found most convenient for general use. Some recent experimental tests with this plate have given remarkable results. In these tests, which were made at the Illinois Steel Works, a rail fastened to a seasoned oak tie with two spikes required a pressure of 5,000 lbs. to spread the gauge $\frac{1}{4}$ in., while the tie-plate moved but $\frac{1}{8}$ in., the inside spike lifting when the rail was subjected to a pressure of 11,230 lbs.; for the standard rail-brace with three extra spikes a force of 17,400 lbs. was required, showing the tie-plate to be equivalent to a rail brace at every other tie. In tests with cedar ties made at Watertown, Mass., a rail fastened with two spikes showed a resistance of 1,267 lbs.; the Servis tie-plate with two spikes showed 7,910 lbs., while the rail-brace with three extra spikes gave 9,200 lbs., or only 16 per cent. more than the tie-plate. It is well to note that cedar ties with the tie-plate offered nearly 80 per cent. more resistance than the two spikes in seasoned white oak.

The Servis tie-plate has recently been adopted in two places where there is extraordinary wear of rails. One of these is on the Louisville Bridge over the Ohio River, and the other on the Manhattan Elevated Railroad in New York, where the track is subjected to as severe wear as on any line in the world.

It is claimed by the manufacturers of the Servis plate—the Dunham Manufacturing Company—that its use will save one renewal of ties; that is, that two sets of ties will wear as long as three without the plate. In this case, if the ties cost 30 cents each, the saving will be $660 per mile, as the renewal of ties, including the labor of replacing them, and taking 2,640 to the mile, will cost $1,056, while the cost of 5,280 tie-plates at $7\frac{1}{2}$ cents each would be $396 per mile. Where the traffic of a road is comparatively light, so that it may not be thought necessary to use these plates on every tie, they can be used to great advantage at exceptional points, as on curves, grades, etc., as indicated above.

The Witherow Blowing Engine.

THE accompanying illustrations—for which and the description we are indebted to the *American Manufacturer*—show an improved pattern of blowing engine built by Mr. J. P. Witherow, of Pittsburgh, at his shops, which are in New Castle, Pa. Fig. 1 shows a one-half side elevation of the engine; fig. 2 a one-half section; fig. 3 a front elevation and fig. 4 an enlarged perspective view of the inlet steam valve.

The general design of the engines, it will be seen, does not vary from that already in common use, but there are some de-

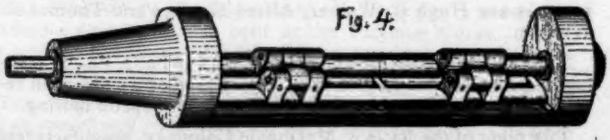


Fig. 4.

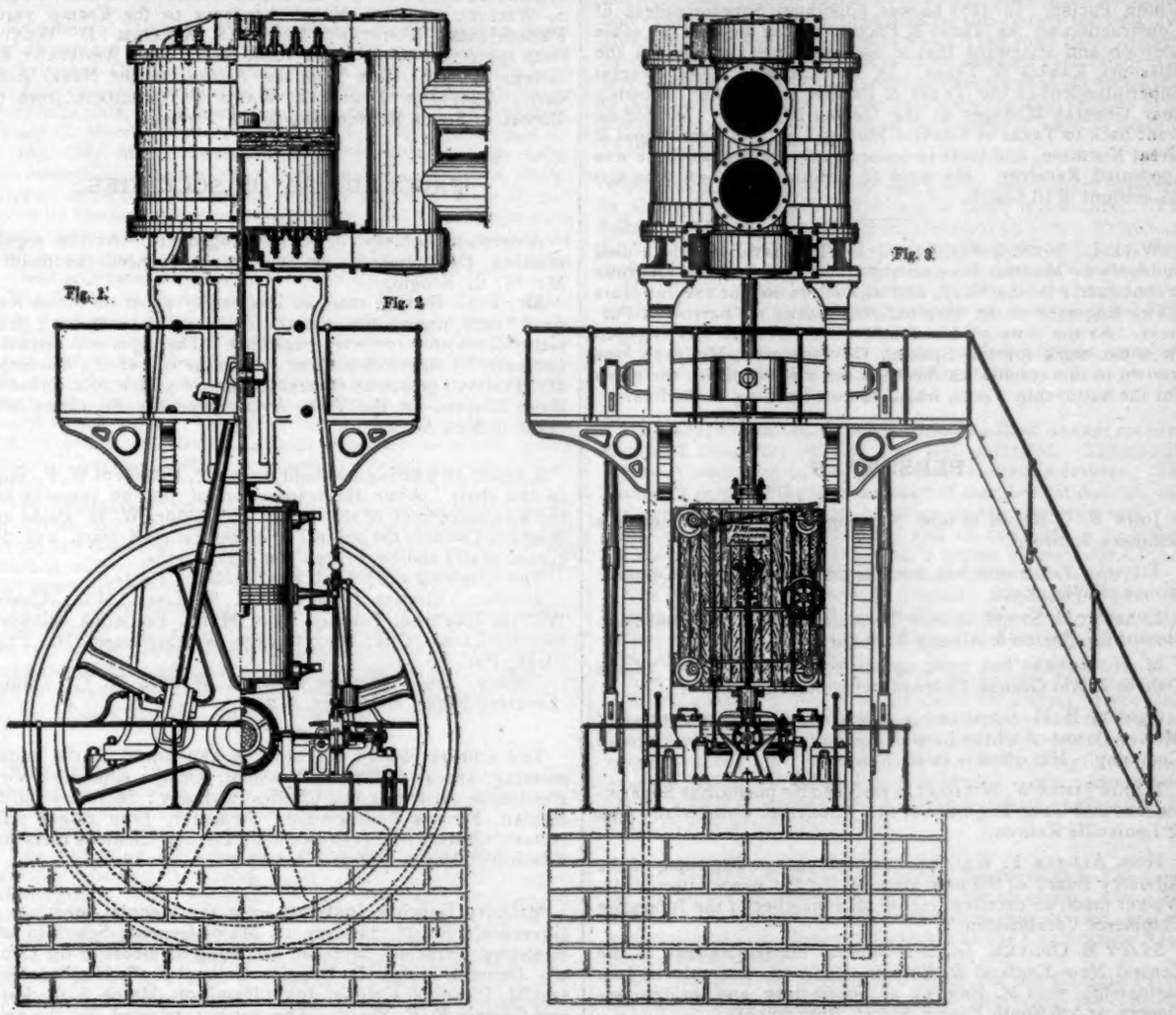
tails in the construction which it is believed add materially to their value and economy in operation, notably among which is the valves for the steam cylinders, which it will be observed from an inspection of the drawings are of the Wheelock type. This will be described in detail below.

The general dimensions of the engines are as follows: Steam cylinders, 42 in. diameter; air cylinders, 84 in. diameter by 60 in. stroke; crank shaft, 14 in. in diameter; height (from floor line), 28 ft. 6 in.; weight, 89 tons.

The steam inlet valve referred to above is shown in fig. 4. The valve seat is of the gridiron type, the valve itself being a flat slide with opening corresponding to those in the seat. The valve is operated by means of a knuckle-joint movement, by the use of which very slight lap is needed, and almost instantaneous opening and closing are secured with great ease of action under the greatest pressure. The movement of the valves under consideration is only $\frac{1}{8}$ in. The valves are fitted to separate seats driven into holes in the cylinder a little tapering, no bonnets being used.

The advantages claimed for this valve are its adaptability to high speed, tightness and freedom from necessity of balancing, positiveness of action and the entire avoidance of wear on the cylinder when in use, all of the work on them being completed before they are placed in position.

Thirteen of these engines are contracted for or now in course of building. Three are in position at the works of the Florence Cotton & Iron Company, Florence, Ala.; the others will soon be shipped to Middleborough, Bristol, and other places.



THE WITHEROW BLOWING ENGINE.

OBITUARY.

COLONEL WILLIAM H. PAINE died suddenly in Cleveland, O., December 31, of heart disease. He was born in Chester, N. H., in 1828, and after an ordinary school education and a short course in engineering he found employment as a land surveyor in Wisconsin, then a new country. From Wisconsin he went to California, and after engaging for a short time in mining, in 1849 he made surveys for a wagon road across the Rocky Mountains. In 1853 he had charge of a party which surveyed the first line across the Sierra Nevada for a Pacific Railroad. When the war broke out he entered the Fourth Wisconsin Regiment, but was appointed to the Engineer Corps, where he remained throughout the war, being employed constantly in preparing maps and other important work. After the close of the war, he resigned, and in 1869 was chosen Assistant Engineer of the Brooklyn Bridge, and in that capacity assisted Mr. Roebling in making the original surveys, superintended the building and placing of the caissons, the building of the New York tower and the laying of the superstructure. He also planned the whole system of cable traction on the bridge. After its completion he resigned and occupied himself as Consulting Engineer, chiefly in connection with cable railroads. He planned and superintended the construction of the cable road on 125th Street and Amsterdam Avenue, in New York City, and prepared the plans for the cable road on the Third Avenue Line, which are shortly to be carried out. He also superintended the building of the cable roads in Denver, Kansas City and Omaha, and at the time of his death was engaged in building a cable road in Cleveland, which is now almost completed. He leaves a wife and two daughters. He was a prominent member of the American Society of Civil Engineers, and was highly esteemed by his associates.

SELAH CHAMBERLAIN, who died in Cleveland, Ohio, December 27, age 78 years, was born in Vermont, and for a short time was a clerk in Boston. When but 24 years old he went to Pennsylvania, where he secured a contract on the extension of the Pennsylvania Canal. He afterward built the Ohio & Pennsylvania Canal and later part of the Wabash & Erie Canal. In 1845 he went to Canada and took a contract for building part of the canals along the St. Lawrence River. When this work was completed he built a portion of the Rutland Railroad in Vermont and later the Ogdensburg & Lake Champlain Road in New York. After completing the latter he went to Cleveland and took the contract for building the entire line of the Cleveland & Pittsburgh Railroad, which was finished in 1851. He then went West and was for a number of years engaged in railroad building there. He constructed and was

largely interested in the Minnesota Central, the La Crosse & Milwaukee, the Southern Minnesota, the Hastings & Dakota and other roads. He held large interests in all of these and was chiefly instrumental in bringing about the consolidation which formed the present Chicago, Milwaukee & St. Paul Company. In 1871 he returned to Ohio and took his last contract, the construction of the Lake Shore & Tuscarawas Valley Railroad, which was later reorganized as the Cleveland, Lorain & Wheeling. He remained President of the Company until his death, and was also interested in a number of manufacturing and other enterprises. Mr. Chamberlain was one of the largest and most successful railroad contractors in the country, and leaves a considerable fortune.

COLONEL J. M. EDDY, who died in Pasadena, Cal., January 12, aged 46 years, was born in St. Charles, Ill., and began railroad work when 23 years old, as an assistant engineer on the Union Pacific. In 1872 he was appointed Superintendent of Construction on the Texas & Pacific. Later he held the same position and afterward that of General Superintendent of the Missouri, Kansas & Texas. In 1882 he was made General Superintendent of the Texas & Pacific, and in the following year General Manager of the Omaha Belt Line. In 1888 he went back to Texas as General Manager of the International & Great Northern, and there remained until recently, when he was appointed Receiver. He went to California a short time ago on account of ill health.

WILLIAM JOHN, a well-known English naval architect, died suddenly in Madrid, December 28. Mr. John was at one time a constructor in the Navy, and was afterward for several years Chief Engineer of the ship-building works at Barrow-in-Furness. At the time of his death, we believe, he was engaged in some work for the Spanish Government. Mr. John was known in this country as the engineer who furnished the plans for the battle-ship *Texas*, which is now building at Norfolk.

PERSONALS.

JOHN F. O'BRIEN is now Superintendent of the Louisville Southern Railroad.

THOMAS THOMPSON has been appointed Railroad Commissioner of Wisconsin.

EVERETT E. STONE is now Roadmaster of the Second Division of the Boston & Albany Railroad.

M. H. ROGERS has been appointed Chief Engineer of the Denver & Rio Grande Railroad, with office in Denver, Col.

GEORGE B. HAZLEHURST is now General Superintendent of Motive Power of all the lines of the Baltimore & Ohio Railroad Company. His office is in Baltimore.

MAJOR JAMES W. WILSON has resigned his position as Superintendent and Chief Engineer of the Knoxville, Cumberland Gap & Louisville Railroad.

HON. ALDACE F. WALKER has been chosen Chairman of the Advisory Board of the new Western Traffic Association. Mr. Walker made an excellent record as a member of the Interstate Commerce Commission.

STACY B. OPDYKE, Jr., late General Superintendent of the Central New England & Western Railroad, has entered into partnership with M. BENNER as contractors and bridge engineers, at 226 South Fourth Street, Philadelphia.

SIR JOSEPH HICKSON has resigned his position as General Manager of the Grand Trunk Railway. He has been connected with the road for 29 years, for 17 of which he has been General Manager. His successor is L. J. SEARGEANT, late Traffic Manager.

THEODORE LANE is now Engineer of Maintenance of Way of all lines of the Norfolk & Western Railroad east of Roanoke, and G. M. THOMPSON of all lines west of Roanoke. R. P. C. SANDERSON is Superintendent of Motive Power of the Western Division of the road.

A. M. TUCKER is now General Manager of the New York, Pennsylvania & Ohio and the Chicago & Erie Divisions of the New York, Lake Erie & Western Railroad. J. C. MOOREHEAD is General Superintendent of those divisions, and J. H. BARRETT is General Superintendent of the Erie Division.

C. F. MEEK has resigned his position as General Manager of the Mountain Division of the Union Pacific to take charge of the affairs of a new electric light, power and railroad company in the City of Mexico. Mr. Meek's successor on the Union Pacific is W. H. BANCROFT, recently Division Superintendent.

BRIGADIER-GENERAL S. V. BENET has been relieved from duty as Chief of Ordnance of the United States Army and placed on the retired list, having reached the statutory limit of age. He was born in Florida, graduated from West Point in 1849, and was then appointed Second Lieutenant in the Ordnance Department. He has, therefore, seen 41 continuous years of service in that department; he has been Chief for 16 years, having been promoted to that position in June, 1874. General Benet's successor is COLONEL DANIEL W. FLAGLER.

THE following recent navy orders affecting the Engineer Corps are noted: PASSED ASSISTANT ENGINEER HERSCHEL MAIN has been detached from the Navy Yard, New York, and ordered to the *Boston*; PASSED ASSISTANT ENGINEER GEORGE S. WILLITS from the Naval Academy to the Cramp yards, Philadelphia; ASSISTANT ENGINEER WILLIAM D. WEAVER from the *Boston* to the Navy Yard, New York; ASSISTANT ENGINEER JOHN L. GOW from the *Fortune* to the Naval Academy; ASSISTANT ENGINEER WARD P. WINCHELL from the Bureau of Steam Engineering to the *Fortune*.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, December 17, the Secretary announced the death of Mr. W. B. Knight.

Mr. T. G. Gribble read an interesting paper on Street Railroad Track, urging the importance of good track for a street railroad, which is too often neglected. The paper was discussed generally by members present, and in the course of a discussion Mr. Tratman presented several sections of girder rails, including those adopted for the Third Avenue and the Broadway cable roads in New York.

A REGULAR meeting was held January 7, President W. P. Shinn in the chair. After the transaction of routine business and the announcement of the deaths of Colonel W. H. Paine and Addison Connor, the subject of street railroad track was discussed orally and by written communications.

The following candidates were declared elected:

Members: Charles Irwin Brown, St. Louis, Mo.; Charles William Hazleton, Turners Falls, Mass.; Frederick Ellsworth Sickels, Kansas City, Mo.; George Westinghouse, Jr., Pittsburgh, Pa.

Juniors: Louis Douglas Fouquet, Walton, N. Y.; Clinton Levering Riggs, Baltimore, Md.

THE officers elected for 1891, as announced at the annual meeting, are as follows: President, Octave Chanute; Vice-Presidents, A. Fteley and Charles Hermany; Secretary and Librarian, Francis Collingwood; Treasurer, John Bogart; Directors, Charles B. Brush, Rudolph Hering, Clemens Herschel, Edward P. North, and S. Whinery.

Military Service Institute.—At the biennial meeting, at Governor's Island, January 14, Major-General Schofield was re-elected President, with the following members of the Council: General George D. Ruggles, Colonel R. P. Hughes, General M. P. Small, Colonel John Hamilton, Major A. E. Bates and Captain E. E. Wood. The subject selected for the prize essay for this year is "'Terrain' in Its Relations to Military Operations."

New England Water-Works Association.—At a meeting held in Boston, January 14, the following members were elected: W. W. Starr, Jr., Bridgeport, Conn.; Frank H. Mills, Woonsocket, R. I.; John D. Shippy, Holliston, Mass.; G. H. Barrus, X. H. Goodnow, S. E. Tinkham, Boston.

Frederic P. Stearns, Chief Engineer of the Massachusetts Board of Health, read a paper on the Effect of Storage on the Quality of Water, giving many interesting facts. It was accompanied by tables and analyses of water. This paper was generally discussed.

Mr. W. E. Davis described his experience in moving 700 ft. of pipe without taking the joints apart.

Boston Society of Civil Engineers.—At the regular monthly meeting, in Boston, December 17, Ellery C. Appleton,

Alfred W. French, Eugene J. Spencer and Elton D. Walker, were elected to membership.

Mr. Howard A. Carson, Chief Engineer of the Metropolitan System of Sewerage, gave an informal talk upon the work under his charge. With the aid of lantern views he described what had already been done on the Brighton, East Boston and Winthrop sections, and gave the costs of the same. He followed this talk with descriptions of the method of tunneling now being used under the Hudson River.

Mr. F. P. Stearns, who was one of the commission appointed to report a system of sewerage for the District of Columbia, was the next speaker. He explained the system recommended, which provides for high level intercepting sewers to take care of the water in the high districts as far as possible, leaving as small a quantity as possible to be pumped from the low districts. About 940 acres would have to be taken care of by pumping. The proposed system was estimated for a population of 500,000.

Engineers' Club of Philadelphia.—At the regular meeting, December 20, Mr. Edward Hurst Brown presented a paper on Suburban Development, in which he referred particularly to the development of suburban places of residence in the vicinity of Philadelphia. There was considerable discussion by Messrs. Henry G. Morris, Robert J. Parvin, A. G. Rudderow and C. H. Ott. Mr. Morris advanced the opinion that a large building, something after the order of the Drexel building in Philadelphia, could be most advantageously used as a place of residence by families; that a city could be constructed with such places on alternate squares, arranged after the manner of the black squares on a checker-board, leaving the other spaces open for healthful breathing spaces and various purposes.

The Secretary presented, for Mr. John Graham, Jr., a paper upon the Use of a Pumping Dredge by the Norfolk Company at Norfolk, Va., and explained its use in the reclamation of low waste land in such localities. He says that the advantages of this machine seem to be its ability to transport material to a reasonable distance; celerity in dredging and removing obstacles to navigation; celerity in filling; economy in removing and depositing the material. There was some discussion by Mr. Robert J. Parvin, in which he referred to dredging work in California.

The Secretary presented, for Mr. G. R. Henderson, a paper on Crown-bar Stays, illustrated by two drawings of stays, and giving the formulas by which they were proportioned in his practice, also the results of actual tests as to strength. There was some discussion.

The Secretary presented, for Mr. Charles H. Haswell, a brief paper upon Shingle for Concrete and Beton. He is of the opinion that shingle under certain conditions is superior to broken stone in the composition of concrete and beton, both in strength and in economy of cost. There was some discussion by Dr. H. M. Chance and Mr. Howard Murphy.

Engineering Association of the South.—At the regular meeting, in Nashville, Tenn., January 8, a communication was received from the Alabama State Technical & Scientific Society, acknowledging receipt of congratulations on its organization.

The following elections to membership were announced: *Members:* George B. Crafts, Atlanta, Ga.; Henry A. Turner, Birmingham, Ala. *Associate:* S. M. Newbold, Birmingham, Ala. *Juniors:* R. L. Johnson, Columbus, Ga.; Thomas B. Wilson, Jr., Harriman, Tenn.; R. A. Chapman, Sheffield, Ala.

Mr. D. W. Cooke exhibited and explained a model and drawing of a proposed system of light-draft towage boats proposed by him for western rivers. The system proposed a series or train of barges each having one convex and one concave end. The convex bow of one was intended to be fitted into the concave stern of the next ahead, in order to do away with but one cross-section resistance in moving through the water. The line of tows was proposed to be drawn by a side-wheel tug at the head of the tow, having the same cross-section and having a concave stern like the other barges. Barges carrying freight to any particular point are intended to be dropped out at way points, like freight cars from a train.

A paper entitled a Study of Steam-Engine Pistons was then presented by Professor W. T. Magruder, of Vanderbilt University. The paper, after going into an extensive discussion of the formation, dimensions, and features of steam pistons for large engines in general, drew a comparison between the best forms in practice and the piston of the Holly-Gaskill pumping engines at the Nashville Water Works, which have twice broken recently. The paper showed that it was highly improbable that the breakage had been caused by the clearance being filled with condensation water.

Mr. Landreth submitted for informal discussion a draft of a Highway Bill which was being prepared by a committee appointed by the Nashville Commercial Club for presentation to the present State Legislature. The bill provides for a State Board of Engineers composed of three members appointed by the Governor, meeting quarterly, having chiefly advisory powers, but having the right to specify and determine the qualifications of County Engineers, and the forms of records and maps by which the work of the several counties shall be recorded. The bill further places the control of each county in the hands of a commission composed of three members to be appointed by the County Court, and requires the Commissioners to place the execution of all work in the hands of a competent County Engineer, who in turn may appoint as many district superintendents as may be essential to maintain the entire road system of the county, each Superintendent being required to devote his whole time to his district, thus securing the *maintenance* of highways rather than their periodical repair. The proposed bill abolishes the civil district or township lines in the collection and expenditure of taxes, thus making the county the unit. and giving each county the option to abolish the road labor system, by reducing the number of days to be assessed each resident to zero if desired. The bill does not increase the road tax above that of the past few years, but in fact substantially reduces it by placing the maximum number of days' labor at eight in place of 12 days, as at present.

Western Society of Engineers.—At the annual meeting, in Chicago, January 7, there was a large attendance. The following officers were elected for the ensuing year: President, L. E. Cooley; Vice-Presidents, J. F. Wallace and J. O. Seymour; Secretary, John W. Weston; Trustee, O. Chanute.

Mr. Cooley delivered the annual address, in which he called attention to the duties of the engineer as a citizen toward the general community.

The meeting was followed by the annual banquet, at which about 200 members and guests were present.

Engineers' Club of Cincinnati.—The third annual meeting was held December 18, and was well attended. Thomas H. Kennedy and Claude Freeman were elected members. The Secretary reported the total number of members at date 96, and the average attendance at meetings during the year 25½. A paper was read at each meeting, and on one night a budget of six short papers. The Treasurer's report showed the Club to be out of debt with a satisfactory balance in the treasury.

The following officers were elected: President, Robert L. Read; Vice-President, Ward Baldwin; Directors, Epes Randolph, W. B. Ruggles and S. Whinery; Secretary, Treasurer and Librarian, J. F. Wilson.

The retiring President, Mr. G. B. Nicholson, read a very interesting address in which he reviewed the history of the club, the progress made since its organization, on which he congratulated the members, and its condition at the present time. He urged upon the club the desirability of procuring permanent quarters and the establishment of a library. His address concluded with a short description of the works of engineering interest in and about Cincinnati.

Engineering Association of the Southwest.—The regular December meeting was held in Birmingham, Ala. The proposed amendment to the Constitution was carried, and the Association will be known henceforth as the Engineering Association of the South.

Mr. A. B. Gude presented a paper on the Georgia Pacific Railroad Bridge over the Yazoo River, describing the construction of the bridge, the special point of interest being the manner of constructing the pier for the draw-span, which was done by driving a large cluster of cypress piles, sawing them off even with the bed of the river, and then placing on top an octagonal grillage of three courses of timbers bolted together, on top of which the masonry was constructed.

A paper on the professional Status of Engineers was read by Mr. William G. Williamson. It treated of abuses in the engineering profession, and of the principles which should control the business relations of engineers with each other and with the public.

On the day following the meeting the members visited the mines and rolling mills at Birmingham, Bessemer and in the neighborhood.

Michigan Engineering Society.—The twelfth annual convention was held at Lansing, January 20–23, when a number of papers were presented and discussed, among them the following: W. B. Sears, Rapid and Accurate Surveying; F. Hodg-

man, That Problem in Surveying, and that Fallacy of the Gradienters; M. E. Cooley, Experiments on Water Motors; N. F. Durand, Behavior of Wood under Stresses; Josiah Ripley, Submarine Work.

The officers of the Society are: President, J. B. Davis; Vice-President, George L. Wells; Secretary and Treasurer, F. Hodgman; Directors, George E. Steele, M. E. Cooley, C. E. Greene.

Iowa Civil Engineers & Surveyors' Society.—The Fourth Annual Convention met in the City Hall, in Des Moines, December 30, with a good attendance of members. The Secretary read a number of letters from absent members, which were of interest to the Society.

The retiring President, Mr. E. M. Gilchrist, then delivered the annual address, which was filled with good suggestions for practical work. The reports of the Secretary and Treasurer showed a slight increase of membership, a small balance in the treasury and a material growth of the library.

The Executive Committee reported the following persons elected to membership: M. V. Ashby, Afton; A. W. Heald, Hawarden; Edward S. Hyde, Paul Ilg, Dubuque; L. Higgins, Des Moines. Messrs. R. S. Finkbine and R. L. Chase, of the Board of Public Works, Des Moines, were elected honorary members of the Society.

The following officers were elected for the ensuing year: President, M. Tschirgi, Jr., Dubuque; Vice-President, William Steyh, Burlington; Secretary and Treasurer, Seth Dean, Glenwood.

A number of papers were read on different subjects. Among others, one by R. G. Brown, of DeWitt, on the Measurement of Earthwork, and one by William Steyh, of Burlington, on Taking Notes for Municipal Improvements, were very full and interesting.

Civil Engineers' Society of St. Paul.—The annual meeting was held at the Hotel Ryan, January 5, President Mason in the chair; 11 members and 1 visitor present.

The minutes of the last meeting having been read and approved, the annual reports of the Secretary and Librarian were read, and, upon motion, accepted and placed on file. President Mason made some remarks appropriate to the end of the year.

The following officers were elected for the ensuing year: President, S. D. Mason; Vice-President, George L. Wilson; Secretary, C. L. Auman; Treasurer, A. O. Powell; Librarian, A. Munster; Representative of the Society on the Board of Managers of the Journal of the Association of Engineering Societies, C. J. A. Morris; Auditor, W. W. Curtis.

The literary exercise was a paper by M. A. Munster upon a Diagram and Formula giving the strength of columns according to Gordon's formula, by a shorter method.

Owing to the lateness of the hour, the discussion was postponed until the next meeting.

Engineers' Club of St. Louis.—At the annual meeting, December 17, the result of the ballot for officers was reported as follows: President, George Burnett; Vice-President, N. W. Eayrs; Secretary, Arthur Thacher; Treasurer, Charles W. Melcher; Librarian, J. B. Johnson; Directors, S. Bent Russell, F. E. Nipher; Managers, J. A. Seddon, J. B. Johnson.

Colonel E. B. Meier read a Memoir of the late Thomas J. Whitman, formerly President of the Club.

The retiring President, Mr. F. E. Nipher, gave an address on the progress of electrical work in St. Louis, showing what had been done in the way of electric light, motors and street railroads.

Mr. H. M. Kibby then read a paper on Cable and Electric Railroads, comparing the cost of constructing and operating street railroads by cable and by electricity. This paper called out a long discussion, in which some interesting facts and figures were given.

At the regular meeting, January 7, a committee was appointed to arrange for the purchase of the library of the late Mr. Whitman.

Mr. J. A. Seddon read a paper on the Economic Design of Settling Basins, giving an account of the best systems which could be adopted in varying conditions, while at the same time providing sufficient surface and storage to permit the water to stand long enough to permit complete settlement of the sediment, etc., and to provide proper facilities for cleaning the basins. The paper was discussed by a number of the members present.

Northwestern Track & Bridge Association.—At the regular December meeting in St. Paul, Minn., a paper was read on the Best Time and Place for Renewing Ties, by Mr. McCutcheon, which was generally discussed by members present, a variety of opinions being expressed.

Mr. E. J. Pearson then read an interesting paper on Temporary Expedients in Case of Fire and Wash-outs, giving description of a number of ways of building temporary trestles and bridges to replace track or water-crossings destroyed, and describing especially the methods in use on the Northern Pacific Road.

Montana Society of Civil Engineers.—At the regular December meeting in Helena, Mont., the Committee appointed to select the representative to serve on the Committee of Arrangements for the International Engineering Congress in 1893 recommended Mr. Elliott H. Wilson. This action was approved. The Committee of Arrangements for the annual meeting reported progress stating that the first day of the meeting would be spent at Marysville visiting the works there.

A paper by Mr. S. J. Jones on the Arithometer was read showing the advantages of the use of this machine upon certain classes of calculations, demonstrations being made on a machine loaned for the purpose. This device is of French invention and is capable of multiplying 16 figures in the multiplicand by eight figures in the multiplier, and performing division with equal facility. It has been in constant use in the Mineral Department of the United States Surveyor General's office for Montana for about four years, mainly upon traverse calculations, and accomplishes results in much less time than is practicable by the use of logarithmic or traverse tables.

New England Railroad Club.—At the regular meeting in Boston, January 14, the topic for discussion was "What Constitutes a Defect in a Vertical Plane Coupler Sufficient to Condemn the Coupler?" There was a very lively discussion, the speakers being Messrs. F. D. Adams, J. W. Marden, John J. Chamberlin, S. M. Butler, W. J. Robertson, J. N. Lauder, Albert Griggs, J. H. Barnes and others. A number of speakers raised objections to the vertical plane couplers principally on account of the fact that the knuckles are so easily broken, entailing expense for repairs, and partly also on account of the difficulty in coupling them with the ordinary link and pin coupler.

The subject for the February meeting is Painting, and Master Painters are invited to meet with the Club.

New York Railroad Club.—At the January meeting, in New York, Mr. A. E. Mitchell, of the Erie, presented a paper on the Qualities Essential for a Free-steaming Locomotive. Mr. W. G. Wattson, of the West Shore, spoke on Car Service.

There was a large attendance at the meeting, and a lively discussion, several of the speakers giving interesting notes of experience.

Master Mechanics' Association.—It is announced that the Annual Convention will be held at Cape May, N. J., beginning Tuesday, June 16. The headquarters of the Association will be at the Stockton Hotel.

Master Car Builders' Association.—The Executive Committee announced that the next Annual Convention will be held at Cape May, N. J., beginning Tuesday, June 9. The headquarters will be at Stockton Hotel, which has made a uniform rate of $3. per day. Messrs. Blackall, Lentz and Kells are the Committee on Headquarters.

NOTES AND NEWS.

Petroleum as a Locomotive Fuel.—A correspondent informs us that many of the locomotives of the Argentine Great Western Railroad are being fitted for the use of petroleum as fuel, and it will probably supersede all other fuel on that road. The oil used is a heavy petroleum found at Mendoza, near the line of the road, which answers the purpose of fuel fairly well, although it has been found impossible to refine it so as to make a good lamp oil. The economy is very considerable, as the railroad company can procure this oil at present at a cost of $12 paper per ton—equivalent to about $3 gold—while English coal, which has been used on parts of the line, costs $20 gold per ton. Fuel is very scarce in the country.

Our correspondent adds that until more economical methods are adopted in operating railroads, the Argentine Republic will never be able to compete with the United States in the grain markets of the world, as it will be impossible to give grain producers low rates to a seaport.

The Albert Bridge at Belfast.—The accompanying illustration, from the London *Engineer*, shows a new street bridge—named the Albert Bridge—over the Lagan River at Belfast, Ireland, which was recently completed from the designs of Mr. J. C. Bretland. The bridge consists of three arches, each made up of 11 cast-iron ribs. The radius of the intrados of the center arch is 99 ft. 10 in., and the intrados of each of the shore

arches is 107 ft. 7 in. The segments forming each arched rib, both of the center and the shore arches, are five in number. Each segment of the cast-iron ribs, both of the center and the shore arches, has intermediate radial stiffeners. All butting surfaces of the segments were planed to radial lines, and most accurately gauged in the workshop to ascertain that these surfaces were perfectly true. No bolt holes were cast, but in all cases they were drilled, and all bosses faced. All bolts, either for joints or for connecting the wrought-iron work, were turned to an exact fit. On the upper flange, and in the positions required, are cast the lugs to which the spandrel pillars and longitudinal girders are to be secured. The pivots are of cast iron.

The contract for the construction of the bridge was taken by Messrs. Henry, of Belfast, for £36,500. The ironwork was supplied by Handyside & Company, Derby, England, the granite being prepared in the quarries at Dalbeattie.

Compound Locomotives in Ireland.—The Worsdell-von Borries-La Page compound engines, which have been recently added to the locomotive stock of the Belfast & Northern Counties Railway, it is said, are giving every satisfaction and working with marked economy. Most careful tests are being made with a view to show accurately the economy of the compound engine over the simple. The engines were built by Messrs. Beyer, Peacock & Company, Limited, of Manchester.

A New Method of Tunneling.—In the construction of the tunnel which is being made for the new main line of the Great Northern Railway Company, in connection with its Metropolitan traffic from King's Cross, a new method of tunneling, the apparatus for which is the invention of Messrs. Jennings & Stannard, Victoria Street, Westminster, is being used. The invention is to facilitate the construction of tunnels, subways, and sewers in cases where it is necessary to support the superincumbent earth, and to prevent subsequent subsidence of the surface. The most frequent cause of subsidence is due to the fact that, to admit of the usual system of timbering, ground above the limits of the permanent brickwork is disturbed or removed, as shown in fig. 1; and as it is seldom thoroughly replaced by packing as solid as the original ground, settlement ensues sooner or later. This new method of tunneling obviates this, as by its use no ground outside the actual section of the subway need be disturbed.

The invention comprises the design and arrangement of a series of steel bars or "needles," which are placed side by side within the excavation, so as to form a complete temporary lining and support to the roof. Within this series of needles the permanent brick arch of the tunnel is built, as shown by fig. 2. The needles used in this work are 10 ft. long, 6 in. wide, and 2 in. thick. They are of sections like those illustrated by fig. 3, and are provided with longitudinal grooves, by means of which each needle is linked to the next one in such a way as to admit of separate longitudinal motion.

The needles are inserted and supported in the same manner as ordinary tunnel bars, the ground being excavated only to the exact section of the tunnel—plus the trifling thickness of the needles. After the brickwork has been built within them the needles are separately pushed forward by screw-jacks, as the ground is excavated for the succeeding length.

The needles are provided with longitudinal tubular cavities, through which grouting or other filling material may be introduced from time to time to fill the space left vacant by the advancing needles between the top of the lining arch and the earth above and around, and this prevents any subsidence. A great saving is effected in the quantity of excavation necessary in the present mode of carrying out works of this description, as by this mode no crown bars or poling boards, as in fig. 1, are necessary, and the excavation is only taken out the size of the brickwork to be built, as in fig. 2, thereby preventing waste of timber or the extra brickwork generally built between crown bars or timbers. In driving sewers, the exact shape of the sewer can be taken out, instead of driving a square heading.

It will not be so often necessary to break up the surface of roads for the construction of subways or passages, as with this method there need be a thickness of only a few feet above the crown of the arch. At King's Cross the heavy goods yard is tunneled by this method to within less than 3 ft. of turntable foundations, the traffic being unimpeded. Part of the work

Fig. 1. Fig. 2.

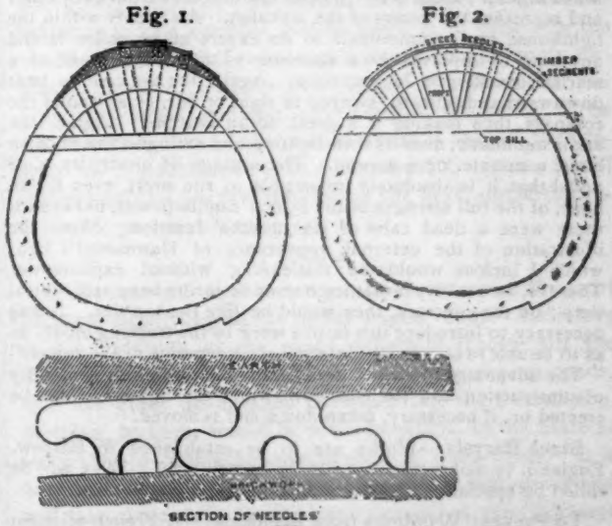
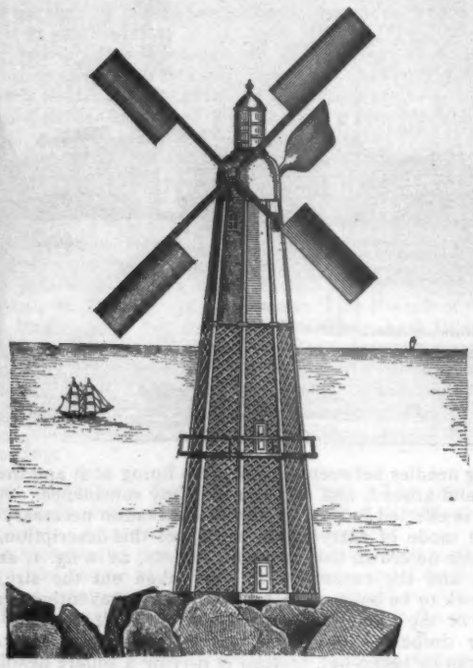


Fig. 3.

would have had to be done in open cutting and traffic stopped, but for this system of working, which saves 3 ft. of headway. A great saving of time is effected by this method. The steel needles will, of course, last many years, and will suit any shape of arch. At the King's Cross tunnel, experience has shown that, besides a great saving of time, there has been a reduction, as compared with the usual method, of about 50 per cent. in the cost of all that part of the work which is affected by the new method—that is, from the crown to the top sill of the face timbering, below which the work is executed in the ordinary manner.—*The London Engineer.*

An Electrical Lighthouse.—The accompanying illustration, which is from the report of United States Consul Connolly, of Auckland, New Zealand, to the State Department, shows a lighthouse devised by Mr. Hannaford, a New Zealand inventor. It is an iron tower, with a windmill attached, which furnishes power to run the electric light, storage batteries being provided to equalize the power and secure a regular, uniform light at all times. The inventor describes its working as follows:

"The Hannaford light is in three tiers up to the revolving cupola (which carries the lamp), but, although the lamp, of



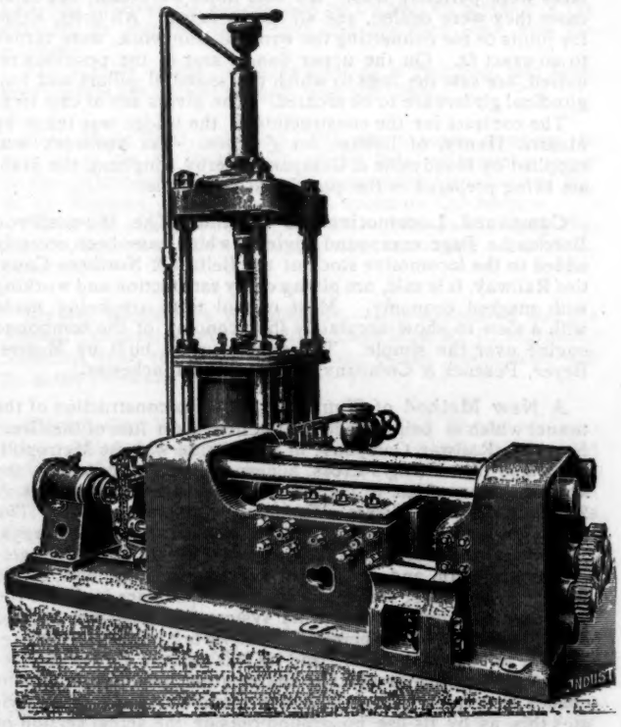
course, revolves with the cupola, the arc within does not, but is always broadside to one desired direction, the lens pulley at its back facing (that is, the back of the lens) the land. Now, the lens has spring slides, which, when operated, send electric flashes that can be plainly discerned a distance of at least 30 miles inland. Each set of flashes are different from each other and represent the letters of the alphabet. An expert within the lighthouse can communicate to an expert many miles inland anything of importance—a supreme value in the event of a marine disaster or in war time. Again, the arc can be bent downward and upward, swayed to right or left, or all round the compass, thus making it a great ocean searcher. Again, the arc is automatic, does its own lighting and extinguishment to an hour, a minute, or a second. The storage of electricity is so novel that it is absolutely impossible to run short, even for an hour, of the full strength of the 15,000 candle-power, not even if there were a dead calm of six months' duration. Now, the illustration of the external appearance of Hannaford's light which I inclose would be misleading without explanation. There is, in reality, no lattice ironwork in the base and central tiers; on the contrary, they would be like the top tier. It was necessary to introduce this lattice work in the working model so as to be able to observe the internal arrangements of the tower."

The advantages claimed are cheapness, durability, simplicity of construction and the ease with which the lighthouse can be erected or, if necessary, taken down and removed.

Steel Barrels.—Works are to be established in Barrow, England, to make steel barrels for carrying oil. They will be rolled by special machinery, devised by Mr. David Caird.

To Prevent Windows from Breaking.—A French scientist says that breakage of glass in windows subject to shocks—as in the neighborhood of mines or quarries where heavy blasts are set off, or near forts where there is practice with heavy guns—may be prevented by pasting on the glass strips of paper crossing each other in different directions. These will prevent or stop the vibrations produced by a shock, which are the cause of breakage of the glass.

Hydraulic Shears Combined with a Steam Intensifier.—A system of working hydraulic shears and other presses by steam intensifiers has been developed on a large scale in Germany by Mr. R. M. Daelen, of Düsseldorf, Messrs. Breuer, Schumacher & Company, Kalk, Cologne, being the manufacturers. It is claimed that it has proved both simple and economical. When hydraulic power is used for ingot shears, and forging and stamping presses, the water pressure must be very high in order to work with cylinders of small diameter. It is difficult to maintain such a distribution of water at high pressure and guard against the waste of water and the consequent loss of power. By the employment of the intensifier the distribution is carried out, and there is only a short pipe from the pump to the large cylinder of the press, so that there is no loss of water. Another difficulty of the hydraulic installations with steam pump and accumulators of high pressure is that the same presssure is used every time upon the piston of the press, while the resistance which has to be overcome is in most cases variable. This leads to a considerable loss of power. The steam intensifier works with a variable pressure, which corresponds to the resistance against the piston of the press, and this effect is obtained by regulating valves of different forms which allow the steam to be used expansively. Some doubt, which was at first expressed, that it would not be possible to work very exactly with a hydraulic piston driven by a steam multiplier, has been dispelled by employing regulating valves in the water pipe. By them the velocity of the water and of the steam piston can be so regulated as to move the piston as steadily as in a simple hydraulic press or shears. The system has been also applied by Mr. Daelen to cranes and hoists, but with lower water pressure. In this case it is very economical in installations where there are only so small a number of cranes to drive that it would be expensive to put in a steam pump and an accumulator. The first design was that of a vertical bloom shears for billets or blooms up to 6 in. square, and flat bars and slabs, while the one shown in our illustration was designed for blooms up to 15 in. and more. There are now in Germany and Austria a number of shears of both designs in use, the weight of which varies between 20 and 100 tons. The billet shears make about 24 strokes per minute, and the largest bloom shears about 12 per minute, while shears driven by a steam-engine make only four to six per minute, and the movement of the blade is not dependent upon the will of the operator, as it is in the one which we illustrate. Large bloom shears have powerful steam-engines,



which run at full speed all the time, returning as well as cutting. Steam of high pressure is used in the single-acting intensifier. There is a small cylinder upon or behind the shears, the piston of which is under steam pressure and works the shear blade. A number of presses of different kinds and sizes are now at work for other purposes, among which is a 5,000-ton press for bending armor plates. Further presses of special design for stamping rolled railroad sleepers are also at work. The system has also been applied to forging presses up to 1,200 tons pressure. The cranes and hoists have chiefly been employed in open-hearth steel works.—*Industries.*